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BUFFALO'S CRUSHER FACILITY FOR BULKY SOLID WASTE

LEONARD S. WEGMAN CO., INC.

PREPARED FOR
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The report gives details on a study conducted to determine the feasibility of presizing bulky municipal refuse discards before charging them into an incinerator. The discards included overstuffed chairs, sofas, other old furniture, carpets, mattresses, springs, washers, dryers, television cabinets, juke boxes, demolition lumber, tree trunks, and automobile tires. Details are provided on the design and operation of the bulk refuse crusher selected.

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PROJECT EVALUATION REPORT

FOR

BULK REFUSE CRUSHER FACILITY

FOR

WEST SIDE INCINERATOR EXPANSION ON SQUAW ISLAND

CITY OF BUFFALO, NEW YORK

1. PURPOSE

The feasibility of presizing bulky municipal refuse discards, such as overstuffed chairs, sofas, other old furniture, carpets, mattresses, springs, washers, dryers, television chassis, juke boxes, demolition lumber, tree trunks, automobile tires; prior to disposal by incineration, thus increasing the ability of new and existing incinerators with limited size charging openings to handle bulky waste that must presently be handled by open dumps or open burning, was demonstrated.

The authority for this demonstration was provided by the Environmental Protection Agency, Office of Solid Waste Management Programs through E.P.A. Grant No. G06-EC-00091.

2. SCOPE

The design, details and functioning of a bulk refuse crusher facility at the expanded West Side Incinerator located on Squaw Island in the City of Buffalo, New York were evaluated.

This facility includes the following principal elements:

(1) Reinforced steel charging hopper.

(2) Power actuated vibrating feeder.

(3) Steel connecting chute, vibrating feeder discharge to crusher.

(4) An impact type crusher with drive and motor.

(5) Steel discharge chute, crusher discharge to power actuated vibrating discharge conveyor.

(6) Power actuated vibrating discharge conveyor.

(7) Inclined flight conveyor to storage bin with drive and motor.

(8) Motor control equipment and interconnecting wiring.

(9) Structural steel supports, platforms, shock absorbers for equipment support and access.

(10) Concrete storage bin to receive crushed material.

(11) Dust collector.

3. SOLID WASTE MANAGEMENT IN BUFFALO

Buffalo, the second largest city in New York State, lies at the eastern end of Lake Erie, near the western edge of the state, in Erie County. The city's area is 42.86 square miles, and its 1970 population was 462,768, or 10,797 persons per square mile.

Approximately 9.14% of the city's land, excluding streets and highways, is devoted to manufacturing, 8.8% to commercial activities, 43.72% to residential use and 14.46% to schools, hospitals and other institutional uses or public facilities. The remaining land area consists of 10.67% streets, 9.07% vacant land, 4.2% ponds, lakes and streams.

Buffalo's population declined by 13.1% from 532,759 to 462,768, in the decade 1960-1970, reflecting the national trend of movement from urban centers to suburban areas. Nevertheless, the city has been confronted with growing quantities of refuse from residential, commercial, institutional and industrial sources. In 1969, Mayor Frank A. Sedita reported that the city's solid wastes had increased by 100% in the preceding ten years. In addition, like most older American cities, it is rapidly exhausting the space available for refuse landfilling purposes within its city limits.

A major part of Buffalo's solid waste problem has been the disposal of bulky refuse. Buffalo boasts thousands of fine old elm trees on its streets. Pruning yields a constant flow of tree parts. Furniture, bedsprings, mattresses, carpets, washing machines, water heaters, tree stumps and branches, demolition wastes from urban renewal and similar oversized discards, both burnable and unburnable, must also be processed.

3.1 The Bulk Solid Waste Problem

About 2,000 cubic yards of bulk refuse, other than demolition waste, are generated in Buffalo each day. Much of this comes from industries, construction firms, or other large sources, which dispose of it

directly to landfills outside the city. Some 63,000 cubic yards, mainly from residential sources, where collected in the city's annual Spring Cleanup drive.

Buffalo has practiced incineration as a means of refuse volume reduction since 1925. (See 3.2 on disposal facilities) However, conventional incinerators, designed to handle household wastes, are unable to receive bulky objects in their original form. A large object, although combustible, may simply be too big to fit into the furnace charging hopper. Even if it can be gotten into the furnace without bridging or jamming, it is unlikely to be burned completely in an incinerator designed for ordinary refuse on a production basis. Such bulk will lead to a decrease in furnace residue quality, and cause jamming of the mechanized stoker and discharge systems. Consequently, it is unwise to attempt burning of whole bulky objects in current incinerators designed for general municipal refuse. Although occasional bulky items can be broken up manually, assigning men to break up large objects by hand is ineffective, hazardous to personnel, and relatively costly.

Without special facilities for presizing or volume reduction of bulky objects, a municipality must resort to open burning, or direct burial. Buffalo has long recognized that open burning is not an acceptable practice in solid waste management. Thus, before its bulk refuse crusher was put into operation, the city buried whole all bulky refuse, and bore the expense for labor, landfill space, and the operation and maintenance of vehicles.

The average density of mixed bulk refuse, measured in the receiving bin at the bulk crusher facility, was 308 lbs per cubic yard*.

---

*The overall density of incombustible refuse alone was even lower, 274 lbs per cubic yard. (See Table 8.4)

Following crushing, the average density increased to 479 lbs per cubic yard. When the bulk was both crushed and incinerated, the average density increased to 1751 lbs per cubic yard. (See Table 8.6 for the computation procedures used in these determinations and Paragraph 5.2 for description of techniques used in volume measurements.) These statistics indicate that the final density of bulk refuse in a landfill after crushing and incineration is 5.7 times greater than the density of the original bulk.

3.2 Disposal Facilities

3.2.1 Incinerators Prior to the Squaw Island Expansion

Buffalo's new bulk refuse crusher is at the expanded West Side Incinerator on Squaw Island, between the Black Rock Canal and the Niagara River. The original West Side Incinerator began operating in 1953. Prior to the recent expansion, it burned about 300 tons of refuse per day in three Monohearth furnaces, originally equipped with mechanical stokers. Natural draft was provided by a chimney 185 feet high and 12.5 feet in diameter.

The city's East Side Incinerator, which was shut down in 1970, burned about 325 tons of refuse per day. That facility consisted of five small natural draft furnaces.

Volume reduction was 70% at both plants.

Neither facility had furnaces capable of handling bulky wastes, such as furniture, large appliances, mattresses, television chassis, juke boxes, hot water tanks, garbage cans, demolition lumber, tree trunks, shrubs, tree branches, automobile tires, hoods and fenders, bicycles, etc. When such items were delivered to the plants, there frequently was a delay while the object was broken up manually.

3.2.2 The Expanded West Side Incinerator

An expansion of the West Side Incinerator was completed in 1969, providing increased capacity, and full air pollution control systems for both the new and existing furnaces. A new three-level traveling grate continuous feed furnace, with a capacity of 200 tons per day, a special bulk refuse burning chamber, and the bulk refuse crusher were installed. The three original Monohearth furnaces have been overhauled and are in service. The new facilities at Squaw Island are described in greater detail in section 4.

The West Side Incinerator now receives 350 tons of refuse per day, including bulk items. Twenty-five tons of this comes from private refuse collection services which pay a tonnage fee to the city.

3.2.3 The Squaw Island Landfill

Before the additional incinerator capacity was built at Squaw Island, the city's solid waste collections, 750 tons per day, exceeded the combined capacities of the West Side and East Side Incinerators. The refuse in excess of incinerator capacity, as well as bulk refuse and the residue from both incinerators, was landfilled at Squaw Island.

The city has expanded the landfill to include 38 acres north of the Canadian National Railroad right-of-way, and bounded on the west by a stone bulkhead along the channel of the Niagara River. The stone bulkhead was built by the city in 1968.

The site is now used only for the deposit of incinerator residue. It is estimated that the site will be able to accommodate all of the city's incinerator residue for the next 15 years.

3.2.4 East Side Transfer Station and Lancaster Landfill

The East Side Incinerator was shut down in 1970, and replaced by a transfer station. Refuse is tranferred from collection trucks

to trailers for hauling to the Lancaster Landfill. The transfer station can handle 400 tons per eight hour shift, but has no capacity for storage of refuse.

The Lancaster Landfill is a privately owned facility in the Town of Lancaster, approximately ten miles east of the transfer station. The refuse is spread, compacted, and covered by the site owner at a charge of $0.20 per cubic yard. Buffalo absorbs the cost of transferring and hauling raw refuse from the East Side Transfer Station to Lancaster. The expected life of this landfill is 50 years, and the owner states that he has access to extensive additional acreage for landfill purposes. The area of this landfill site is in excess of 1,900 acres.

4. PLANNING AND IMPLEMENTING THE SQUAW ISLAND EXPANSION

The City of Buffalo initiated a program in 1961 to rehabilitate and expand the West Side Incinerator plant. The program was completed on October 17, 1969 with the dedication of the expanded facility.

The enlargement increases the plant's capacity to 660 tons per day. New equipment, in addition to the bulk refuse crusher, includes a complete new incinerator train, consisting of a three-level traveling grade furnace, a special chamber to accept and burn bulky uncrushed items; and enlarged wet bottom settling chamber, spray chamber and large diameter cyclone fly ash collectors, to provide air pollution control meeting New York State standards. The furnaces in the existing plant were upgraded with similar air pollution control devices. The air pollution control equipment was extensively tested in 1970, and stack emissions were found to average about 0.115 grains/SCF corrected to 12% CO_2, which equivalent stack particulate emission in #/hr easily meets the State standards. (See Tabulations, Pages 11 and 12)

4.1 Incineration Objectives

4.1.1 Increase Capacity

This generally reduces the amount of refuse going to landfill, and eliminates the need for landfilling of raw refuse at Squaw Island.

4.1.2 Improve Burn-Out

A volume reduction of only 70% was being obtained at the original West Side facility. This was due in part to overloading of the three batch-fed furnaces. More efficient burning further reduces the amount of material--in this case, incinerator residue--ultimately going to the landfill. Reduction in the amount of residue also reduces labor cost entailed in residue handling. Labor cost represents a major share of the overall cost of incinerator operation.

4.1.3 Minimize Air Pollution

The East Side Incinerator and the West Side Incinerator, prior to expansion, were both significant sources of air pollution. The

rehabilitation of the old West Side furnaces, and the closing of the East Side plant, enables the city to meet the standards of the New York State Air Pollution Control Board.

4.2 Incinerator Improvements

The major components of the expanded West Side Incinerator are shown in section 9, Drawings and Diagrams. Only the Shredder facility is included in the federally funded project.

The new furnace is a continuous feed unit, utilizing a traveling grate, with a capacity of 200 tons per day. The extra tumble is designed to provide a better residue than the conventional two-level traveling stoker. Air-cooled silicon-carbide facing in the furnace wall minimizes slagging, and extends furnace life. A new flat-hearth bulk-burning chamber, operating in the line of hot gases off the main unit, is capable of burning 60 tons per day of such bulky wastes as tree stumps. The three existing furnaces, all batch-fed rotary units, provide a capacity together of 400 tons per day.

The original West Side receiving bin had a capacity of 1300 cubic yards. Two additional bins have brought bin capacity to 4500 cubic yards, or about 150% of the daily furnace capacity. Two bins receive incoming refuse; the third holds refuse after processing through the bulk crusher.

Two cranes, each rated at five tons, and equipped with 2-1/2-yard grapples, transfer refuse from the bins to the crusher, and to the furnace charging hoppers. Each crane can service the crusher, as well as the three bins and four furnaces.

The original West Side chimney was 185 feet high, with a nine foot interior diameter at the base. The new chimney is the same height, but with a twelve-and-one-half foot interior diameter at the base.

Residue handling is provided in the new addition by a drag conveyor in a water trough aligned to serve both the continuous feed furnace and the bulk burning chamber. Residue is discharged into a truck inside

the building. Discharge from the three circular furnaces, after water quenching, feeds directly into residue trucks.

Automatic color-coded loop controls, with manual overrides, govern furnace temperature, draft, cyclone collector efficiency, and flue-gas cooling.

An emergency generator protects the plant against electric power outages. In case of such an emergency, or failure of the water cooling system, a fail-safe mechanism closes access to the cyclone collector, and opens the by-pass flue for natural draft discharge, thereby preventing possible damage to the collector and induced draft fans.

The new continuous-feed furnace was provided with five air pollution control features: (1) increased burning length to maintain high temperature; (2) a passage configuration which promotes gas mixing; (3) a low-velocity chamber to promote dropping of large particles from the gases; (4) high-pressure tower and curtain water sprays to lower the temperature of the flue gases, and aid further removal of small particulate matter and trace gases; and (5) variable-capacity, large-diameter cyclone collectors to remove most of the remaining fine particles from the gas stream. Dust particles discharge through rotary valves to a sluiceway system connected to the wet bottoms of the upstream chambers. Flushing nozzles aid transport of the fly ash slurry.

The existing batch-fed furnaces were newly equipped with (1) wet-bottom particle-settling chambers with pressure nozzle flushing to a sluiceway and pumping station; (2) high-pressure tower and curtain water sprays, and (3) variable-capacity large-diameter cyclone collectors.

Fly ash from the settling chambers and cyclone collector sluiceways is moved to four lagoons, where particles settle to the bottom, from which they are periodically removed to the final disposal area. The fly ash quenching water is recirculated to the incinerator and used again.

Independent air pollution tests by the Wisconsin Chemical and Testing Co. of Milwaukee on the new air pollution control systems were conducted in 1970. The test results show that the dust emission levels leaving the stacks at the West Side plant bettered the New York State standards, by considerable margins. Their findings on the new continuous furnace are summarized below:

"Using the refuse charge rate data presented earlier in this report and Figure 1 - Incinerator Guide Particulate Emission Rate vs. Refuse Charged of the New York State Air Pollution Control Board Rules, the following table can be developed:

Test Run	Refuse Charge Rate #/Hour	Refuse Charge Rate % Capacity	N.Y. State Allowable Particulate Rate-#/Hr.*	Stack Particulate Emissions-#/Hr.
1S	23,400	140.5	33.0	20.40
2S	23,400	140.5	33.0	17.94
3S	23,400	140.5	33.0	17.28
4S	19,810	119.0	30.0	10.10
5S	19,810	119.0	30.0	12.66
6S	19,810	119.0	30.0	23.58
7S	22,730	136.7	32.0	19.26
8S	19,900	119.4	30.0	15.96
9S	16,630	99.7	24.0	21.18
10S	20,050	120.3	30.2	12.72
11S	20,050	120.3	30.2	20.04
12S	20,050	120.3	30.2	21.18
13S	18,620	111.8	27.0	14.94
14S	18,620	111.8	27.0	14.58
15S	18,620	111.8	27.0	12.66

* - From Figure 1, N.Y. State Rules

"From the above table, it can be seen that the stack particulate emissions readily meet the State of New York Particulate Emission Rate Limitations for incinerator emissions. The stack particulate emissions ranged from $\frac{24.0 - 21.18}{24.0} \times 100 = 11.75\%$ to $\frac{30.0 - 10.10}{30.0} \times 100 = 66.40\%$ below the New York State requirements for the fifteen stack emission tests conducted over the five day test period."

The Wisconsin Chemical and Testing Co. test results for the batch fed furnaces are summarized below:

"Using the refuse charge rate data presented earlier in this report and Figure 1 - Incinerator Guide Particulate Emission Rate vs. Refuse Charged of the New York State Air Pollution Control Board Rules, the following can be developed:

Test Run	Refuse Charge Rate - #/Hour	N.Y. State Allowable Particulate Rate-#/Hr.*	Stack Particulate Emissions-#/Hr.
1S	42,000	70.0	22.50
2S	40,600	66.0	22.98
3S	42,000	70.0	30.36
4S	59,500	87.0	26.58

* - From Figure 1 - N.Y. State Rules, Part 194

"From the above table, it can be seen that the stack particulate emissions from the old stack serving the #1, #2 and #3 Incinerator units readily meet the State of New York Particulate Emission Rate Limitations for incinerator emissions. The stack particulate emissions ranged from $\frac{70.0 - 30.36}{70.0} \times 100 = 56.6\%$ to $\frac{87.0 - 26.58}{87.0} \times 100 = 69.5\%$ below the New York State requirements for all of the stack tests conducted in these studies."

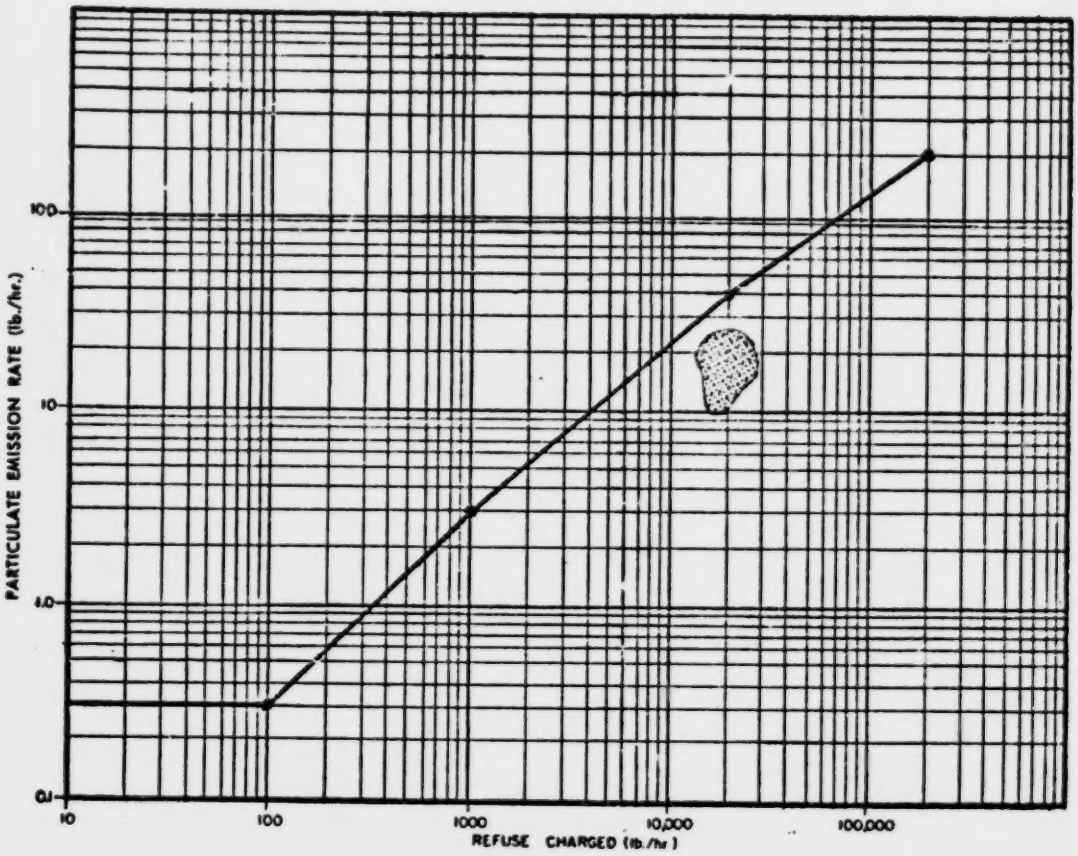

FIGURE 1

INCINERATOR GUIDE
PARTICULATE EMISSION RATE VS REFUSE CHARGE

—— Solid line denotes New York State maximum particulate emission rate plotted as function of refuse charge.

All test data points fell within shaded area.

4.3 Pre-Sizing of Refuse

The bulk refuse crusher at Squaw Island is the first to be installed in a municipal refuse incinerator plant in the United States. It is intended to increase the efficiency of incineration and to reduce the volume of refuse requiring landfill.

Various types of size reduction machinery, including grinders, shredders and crushers, have been used in the processing of municipal solid wastes. Food waste grinders, in particular, have been used for more than 40 years. The home garbage grinder, which discharges into the sewer system, is now commonplace in manny communities, but larger food-waste grinders have long been used by municipalities and food processing industries to prepare garbage for composting or feeding to hogs.

In recent years, municipalities in the United States have shown increasing interest in the pre-sizing of non-food wastes or mixed refuse as an auxiliary process in various types of refuse disposal. This requires heavier and more sophisticated equipment, able to handle material with a wide range of physical characteristics. However, the development of such equipment has not received as much attention in this country as in Europe, possibly because composting is more widely practiced there.

Pre-sizing has decided benefits for both sanitary landfilling and incineration, which, open dumping aside, are the refuse processes most widely used in the United States. Moreover, both incineration and sanitary landfilling are used as disposal methods by the City of Buffalo.

Benefits of pre-sizing of refuse are simplified handling, spreading and compacting. Reduced cover material requirements for landfilling result since voids in the refuse, which otherwise need cover material to fill, are essentially eliminated. Pre-sizing minimizes problems of settlement, especially uneven settlement. This was seen in a demonstration project at Madison,

Wisconsin, carried out under the Federal Environmental Protection Agency's Grant No. D01-UI-0004. The sanitary aspects of the raw refuse were improved, and it was easier to obtain high compaction and uniformity of the fill.

Incineration benefits of pre-sizing include increased refuse surface, providing for rapid oxidation, which results in more complete burning and a lower volume of residue. The pre-sizing process homogenizes refuse, mixing slow burning materials with others that burn more easily. The more uniform feed resulting approaches a correspondingly constant Btu value, which aids incineration operations. An incinerator designed expressly for use with shredded refuse can incorporate certain advanced combustion techniques, and the problems of uneven fire beds and requirements for fire-bed agitation are simplified. Pre-sizing of all refuse was not feasible in the expansion of the West Side Incinerator in Buffalo.

The Buffalo bulk refuse crusher facility was designed specifically for the pre-sizing of bulky solid wastes. The equipment that has previously been used for shredding of ordinary household and commercial refuse is generally not suitable for handling very large objects. The Gondard and Tollemache hammermill type grinders, used at Madison, had built-in features to reject heavy or oversized objects before they reached the grinding section.

A number of both foreign and domestic crushers were examined before choosing a unit. On-site inspections of operating equipment were conducted in Western Europe and the United States. The basic requirement of the machine was its ability to effect the comminution of the wide range of bulky objects likely to be encountered.

The Hazemag Crusher, manufactured by Hazemag of Munster, West Germany, was selected primarily on the basis of its record of successful use in Europe. No other crusher, made in the United States or in Europe as of 1967, was found to have the capability required for the Buffalo facility.

Besides satisfying the basic requirement of being able to reduce in size a wide range of bulky objects, the machine was ruggedly built and judged eminently suitable for the severe duty that it would experience in this type of municipal service.

Other equipment types given consideration before finally deciding for the Hazemag unit were as follows:

a) Lindemann Shear System

Size reduction with this system is obtained by shearing action. The bulky waste material is dumped on a feed apron and then advanced forward by an adjustable stroke, hydraulic ram pusher. The material is thereby positioned so that vertically acting, hydraulically operated blades, with both longitudinal and lateral cutting edges, shear the material to size.

The limitation of this system is its inability to achieve the degree of size reduction possible with other available equipment. Particle sizes of 14 inches are about the smallest that are obtained with this system.

b) Joy Crusher-Disintegrator

Size reduction here is effected by the use of an upper and lower converging conveyor system arranged for compression feed of the bulky waste material into a series of parallel acting high-speed impactor and low-speed star wheels which, interacting, serve to disintegrate the bulky waste.

This unit achieves a fine size reduction on bulky waste materials including rubber tires and rags. However, its design and construction was not deemed sufficiently rugged for the intended service. Maximum size tree trunk that this machine could handle was limited to 12 inches in diameter. This was considered too

small for the requirements of the City of Buffalo, since it was intended that the machine be capable of processing felled, diseased elm trees whose diameters frequently exceed 12 inches.

c) Hammermill Machines

Both vertical and horizontal type hammermill machines were considered for the application. As stated previously, the Gondard and Tollemache machines, which are vertical units of European origin, were limited in their ability to handle large bulky items.

Horizontal hammermill machines were offered by two American manufacturers, the Gruendler Crusher and Pulverizer Company of St. Louis, Missouri and the Pettibone Company, a subsidiary of the Pettibone-Milliken Corporation of Cedar Rapids, Iowa.

Gruendler's proposal consisted of a two-stage reduction system requiring a primary and secondary shredder. The system, however, was limited to the processing of household waste, as would be deposited into 20-gallon household containers. At the time, Gruendler did not believe their machines capable of handling the larger bulky waste items, which was required for the Buffalo facility.

The Pettibone proposal consisted of a swing hammer type hammermill machine equipped with a 2000 hp drive motor identical in design and construction to that successfully used in service shredding automobile bodies for the steel scrap industry. This machine was thought to have considerable merit, particularly in its superior ability to process flexible material such as mattresses, rugs, textiles, and rubber tires and its capability for a more complete maceration of metal products such as stoves, ovens and other such appliances.

Of concern, however, was the ability of the machine to consistently pass the bulky waste material without jam up. Hazemag, by

discrete geometric arrangement of inlet, rotor, impactor plates, enclosure shroud and discharge, and a unique release mechanism on the impactor plates which allows uncrushables to pass through the machine without jamming it, had achieved a high degree of stall-free performance in working installations handling refuse and bulky waste in several European installations. Evaluation of the Pettibone machine, as proposed at the time, left considerable doubt as to its ability to perform as consistently without frequent forced shutdowns due to blockages.

Therefore, because Pettibone had no prior experience in processing municipal refuse including bulky waste, whereas Hazemag had; and since the Hazemag machine required less horsepower, 400 hp compared to 2000 hp on the Pettibone machine; and because the Hazemag unit was capable of fulfilling the primary need for size reduction of Buffalo's bulky waste which could otherwise not be fed into their incinerators, decision was made for the Hazemag unit.

Before finalizing the selection of the Hazemag machine, witness tests and inspections of three working installations were made in December, 1967. A report thereon, dated January 5, 1968, is included under section 10.

Manufacturer's specification data on the Hazemag machine are included under section 11.

4.4 Bulk Refuse Crusher Demonstration Grant

The innovative nature of the bulk refuse crusher proposal required that the city decide to seek a federal solid waste disposal demonstration grant for engineering and construction of the bulk crusher. The grant program, then administered by the Public Health Service, was authorized by Section 204 of the Solid Waste Disposal Act (Title II of Public Law 89-272). The program has since been expanded and is now administered by the Office of Solid Waste Management Programs of the Environmental Protection Agency.

An application for a grant of $538,400 was submitted on April 28, 1967. The objectives of the bulk refuse crusher project, as stated in the application, were:

1. "to reduce bulky and oversized burnable solid wastes to sizes readily handled in both new and existing furnaces," and
2. "to reduce the size of unburnable oversized discards to conserve space in the disposal area land, or make such discards acceptable for salvage as scrap."

It was anticipated that, with completion of the crusher, the city would arrange to collect all oversized discards separately from general garbage and refuse for processing in the bulk refuse crusher. Open burning of solid wastes in the city would be prohibited.

The requested grant was approved by the Public Health Service. Engineering and construction of the crusher facility as well as an evaluation of the project was included in the scope of the demonstration grant.

The evaluation was to obtain and tabulate data reflecting the following:

1. Receipts of bulk items by type, weight and volume.
2. The ease or difficulty in processing through the crusher and auxiliary components.

3. The ability of the existing circular furnaces to accept and consume the crushed bulk.

4. The reduction in volume of non-combustibles to determine the land volume saved.

5. The cost of labor and electric power to operate the facility.

6. Type, weight, size and volume of incombustible bulk items before and after crushing.

7. Volume and weight of crushed materials fed to the furnaces.

8. Investigation of the extent of weight and volume reduction by incineration of crushed burnables.

9. Analysis of incinerator residue to reflect combustibles, ash and inerts.

10. Furnace temperature, draft, combustion air (distribution and pressure) and grate speeds.

11. Comparisons between bulk and crushed materials processed in existing batch-fed furnaces, the new continuous feed unit and the batch-fed bulk burner section included in the new incinerator train.

4.5 Crusher and System Description

Layout and elevations of the crusher and system are shown in section 9, Drawings and Diagrams.

A 5-ton crane equipped with bucket grapple loads a vibrating feeder trough which provides a controlled continuous feed rate to the crusher. The vibrating feeder discharges through a chute attached to the 10.0' wide by 5.0' high crusher feed opening. A flexible curtain is provided to prevent refuse from being hurled back out of the crusher.

The crusher is a Hazemag impact crusher SAP 5/M with a manufacturer's rated capacity of 240 cubic yards of bulk refuse per hour. It is driven by a 400 HP, 1200 RPM motor via a safe-start fluid coupling and vee belts. Free wheeling power input to the motor is 67 kilowatts.

The feed is caught by a rotor provided with crushing teeth, and rotating at 430 RPM. The bulk refuse is projected against adjustable,

suspended impact plates arranged tangentially to the rotor. Hydraulic units enable the gap settings between impact plates and rotor to be changed so that crushed product size may be changed or jams removed.

Crushed refuse passes via a discharge chute to a vibrating conveyor trough, which feeds it to an inclined pan conveyor. A dust hood with take-off to a double cyclone is provided at the conveyor feed end. A fire control water spray unit is provided near the head end. Discharge of refuse is to a concrete bin, where it is held until removed by crane for charging to a furnace.

Electric control interlocks are provided so that a stoppage at any point will shut down all units.

5. CRUSHER TESTS

5.1 Preliminary Tests

Construction of the crusher facility and the installation of related equipment, such as the control room and conveyor discharge, was completed in the fall of 1969. Engineers from Wegman, Hazemag (the manufacturer) and Plibrico (the incinerator contractor) conducted demonstration runs prior to the dedication of the expanded West Side plant. There were no operational difficulties.

After the dedication, Wegman and Hazemag engineers conducted a training program for city personnel in the operation and maintenance of the crusher and its auxiliary equipment.

Regular operation of the crusher was delayed by the failure of the crusher drive motor, which proved to be defective after a few hours service. A new 400 horsepower motor was provided by the manufacturer, General Electric, and installed in December, 1969. The crusher was then operated on miscellaneous bulk and logs, up to 30 inches in diameter by 8 feet long. The crusher functioned well, except for one jam. This was attributed to the configuration of the discharge chute, which sometimes became clogged, and caused the crushed material to become backed-up inside the crusher housing. The problem was noted as one to be watched for in subsequent tests.

Further tests of the crusher were conducted during the next few months. On one occasion, approximately 400 cubic yards of bulk was put through the crusher with no apparent problem. Household appliances, heavy corrugated cartons, crates, logs and other bulk items were fed through the crusher for a one-hour period in a second test. No difficulties were encountered.

During a third one-hour test run conducted on a different day, the crusher jammed again. Inspection confirmed that the jam was caused by the configuration of the discharge hopper. A simple modification in the chute interconnecting the crusher and the vibrating discharge conveyor relieved the problem.

The original chute design provided for a converging section wherein the 10'-0" chute width at the discharge of the rotor was reduced to 6'-10" in the 4'-0" drop to the vibrating discharge conveyor below; this convergence required opposite sides of the chute to slope about 26° off the vertical. After experiencing the stoppages described above, it was concluded that the vibratory motion of the discharge conveyor would be more effective in moving the crushed material forward if the sloping sides of the chute were made vertical. This change was made and, in addition, the vertical sides were stepped back with new ledge panels to obtain the 10'-0" width required to coordinate with the crusher rotor length dimension. The chute modification is shown in section B-B of Drawing 9.4 which is included under section 9 of this report.

The old East Side Incinerator was shut down in mid-1970 and work was begun on converting it for use as a transfer station. While that work was going on, it was necessary to use the full capacity of the West Side Incinerator for ordinary refuse, including putrescibles. As a consequence, and combined with a seasonal low in bulk collections, very little material was delivered to the plant for processing through the crusher.

Preparation for the planned crusher tests began in November 1970, following installation of a dump box on the scales and the arrival of the recording ammeter. A forty minute trial run was conducted on the accumulated bulk which, due to the shortage of storage space, had been piled on the charging floor. The material was approximately 30 cubic yards in volume and contained logs, refrigerators, water heaters and crates.

5.2 Crushing of Incombustible Bulk

The crusher tests, and collection of the necessary data, was carried out during the period from January to June, 1971.

The initial data evaluation plan had called for separate tests of incombustibles, mixed and combustible bulk refuse. Delay in the completion of the East Side Transfer Station caused an unusually heavy load on the West Side Incinerator. The demand on the incinerator facilities, including the cranes, was such that the testing was subject to many interruptions and delays. The tests of the incombustible and mixed bulk refuse were completed, but it was not possible to conduct separate tests on the combustible bulk.

Testing of the incombustible bulk material was carried out from January 12 to April 8, 1971. City trucks collected bulk refuse items which had been set out at the curb and delivered the material to the incinerator plant. When enough material had been accumulated, a crusher run was performed.

Nineteen runs were done on incombustible bulk refuse with a total operating time for these runs of 9 hours and 50 minutes. The crew consisted of a crane operator and three laborers. Crushed items included 177 refrigerators, 157 hot-water heaters, 177 washing machines, 81 stoves and 7 drums, with a total weight of 59.35 tons. Crushing reduced the volume of the incombustible bulk by 46% from 434 cubic yards to 235 cubic yards as measured in the storage bins.

Crushing of the incombustible bulk resulted in very little fine material. Sheet metal from appliances was torn off in large pieces, and came through the crusher as crumpled sheets of from one-half square foot to 12 square feet in area. The larger sheets came through in unpredictable

random dimensions, i.e.: 4 ft x 3 ft, 6 ft x 2 ft, etc. Heavier gauge metal, as from hot-water heaters, was cycled in the crusher until reduced to a compact mass with one dimension small enough to pass through, i.e. approximately eight inches. Inspection of the crushed material indicated the following volume percentages of crushed product sizes measured according to greatest dimension:

Over 12 inches - 93%

4 - 12 inches - 6%

Under 4 inches - 1%

The time required to separate the incombustible bulky items from the combustible bulky items prior to crushing was at least twice as long as that required for the crushing runs. A great deal of trash was mixed with the incombustibles at the point of loading. The extraneous material had to be sorted out and removed by hand; a difficult and tedious process. Each bucketful of bulk was deposited on scales, and weighed before being dumped into the vibrating feeder trough.

No deliberate attempt to compact the bulk material was made in any of the volume measurements. Techniques for obtaining the volume data were as follows:

a) before run, material was leveled in bin and height of material noted by measuring down from top of bin to surface of material.

b) after run, material was again leveled and new height noted, again measuring down from top of bin.

c) the difference in the heights noted, before and after the run, multiplied by the plan area of the bin is the volume change for the run.

No difficulties were experienced in running the incombustible material through the crusher, nor was any substantial wear noted on the contact parts of the crusher. Total energy consumption during these runs was 1780 kilowatt hours (see Table 8.2).

5.3 Crushing of Mixed Combustible and Incombustible Bulk

Crushing of a mixture of combustible and incombustible bulk was started on April 19, 1971 and continued until June 3, 1971 when the city required the use of all storage space and combustion equipment to handle the heavy volume of refuse arriving at the West Side Incinerator.

The mixed bulk processed during this period had a pre-crushed volume of 5,129 cubic yards and weighed 785 tons, or 306 pounds per cubic yard. Energy consumption was 7,900 kw hours (see Table 8.2).

Seventy-two hours of actual operation were required to crush the mixed bulk, a rate of 11 tons per hour. The rate by volume was 72 cubic yards per hour, compared with 44 cubic yards per hour for the incombustibles.

Stoppages during the tests amounted to 26 hours of down time to clear the crusher. However, on three occasions, plugging of the rotor ended the run, and clearing took an additional seven hours per stoppage. On one of these occasions, an additional eight hours was required on the following day to replace pans stripped off the inclined discharge conveyor.

Down time during the tests is tabulated in Table 8.3. The items that caused the greatest difficulty were mattresses, springs, tires, carpets and refrigerators. A charging rate of more than 70 cubic yards per hour of mixed bulk was prone to cause plugging. Springs and mattresses were invariably present in such plugs. Carpets and tires were sometimes involved in such stoppages, but also frequently passed through the crusher virtually unaffected. Refrigerators occasionally bridged across the rotor feed chute, blocking the passage. This also occured with hot water heaters, but less

often. However, when these last two items were charged without accompanying bulk, they presented no problems. Bed springs caused jams on the discharge conveyor by becoming wrapped around the pans and drive shaft.

Three hazards were observed in the crushing of the mixed bulk. Metal, that had become heated from remaining an excessive length of time in the crusher, sometimes ignited combustible materials, such as mattress stuffing. The protective curtains of the vibrating feeder discharging to the crusher were inadequate to prevent chunks of metal, impelled by the turbulence and reflecting surfaces inside the crusher, from being thrown back out through the feed opening. Some of these chunks are rather large and all were moving at great speed. Although audiometer tests were not conducted, sound levels generated during crusher operation appear high enough to warrant some noise reduction facilities.

5.4 Combustion Tests

The first combustion test of the crushed mixed bulk was carried out at furnace No. 4 (the new three-level traveling grate unit) from midnight of April 30, 1971 to 6:30 the following morning. The furnace was charged exclusively with the crushed mixed bulk.

During the test the temperature of the furnace dropped from 1800°F. at midnight to 500°F. at 6:30 a.m. All attempts to maintain necessary operating temperatures were futile. The temperature loss was attributed to the excessively high proportion of incombustibles in the crushed bulk.

The high proportion of metals caused other problems as well. Much crumpled sheet metal was dragged by the return pass of the stokers to the rear doors. Molten metals built up between stoker links and accumulated in the siftings on the tuyere pans. Various adhesions to the top surfaces of the grates occurred, which were difficult to remove.

Subsequent combustion tests charged the furnace with a total of 312 cubic yards of crushed mixed bulk containing less incombustibles resulting in a residue with a wet weight of 53.35 tons and a net volume of 60 cubic yards (see Table 8.5). Later tests showed that, when the proportion of crushed mixed bulk in the feed was limited to 25% and 33%, with the balance of the feed being uncrushed mixed refuse, overall combustion and temperatures were satisfactory. Nevertheless, some problems remained with bedsprings in the residue conveyor.

An attempt to burn crushed mixed bulk material in one of the batch-fed furnaces was abandoned after three hours. The accumulations of spring wire could not be removed through any opening in the furnace, and had to be cut up with a torch.

When furnace No. 4 is charged exclusively with crushed mixed bulk, there is a danger of the fire working its way up through the charging chute, and bursting out in the charging hopper.

5.5 Analysis of Residue Samples

Four samples of crushed mixed bulk incinerator residue from the West Side Incinerator were sent to Pittsburgh Testing Laboratory for analysis. Two samples, of 32 and 44 pounds, were taken from the new furnace No. 4; samples of 24 and 27 pounds were taken from furnace No. 1, the batch-fed unit.

Large metal pieces were removed from each sample. The balance was considered ash and combustibles. The ash portion was quartered, and samples were removed and tested for total combustible matter (loss on ignition).

Samples from furnace No. 4 were obtained from an incinerator test in which the charge consisted entirely of crushed mixed bulk containing a high proportion of metals. Consequently, the average percentage of metallic residue to overall residue is 45%.

The feed for furnace No. 1 consists of a charge in which the crushed mixed bulk was limited to 25%-33%. The metallic content of the residue is consequently lower. Garbage constituted the remainder of the charge, accounting for the 59%-60% non-metal content in the total residue. Considerable fusion was noted in both metallic and non-metallic material in the residue (see Table 8.5).

5.6 Crusher Wear

The only part of the crusher that appeared to be structurally inadequate was the 3/8 inch roof plate of the crusher housing. This plate was stretched due to bombardment by chunks of metal impelled by the rotor teeth.

At the end of the testing period, wear of the rotor teeth did not exceed 5/8 inch on the striking surface, as shown in Figure 9.5. The crusher had then been used a total of 200 hours; 118 hours prior to testing, and 82 hours during testing. Continued use of the teeth, without replacement, up to about 2 inches of wear, is possible with little loss in crushing efficiency, since the position of the impactor plates can be adjusted to maintain optimum crushing clearances regardless of wear. Extrapolating the data compiled in the tests, rotor teeth are expected to have a useful life of 600 hours, corresponding to approximately 6000 tons of mixed refuse processed through the crusher. The 1-1/2 x 1-1/2 inch strips running lengthwise of the rotor were worn, but still effective at the end of 200 hours of operation. Its useful life, before replacement, is expected to be about the same as for the rotor teeth.

5.7 Mechanical Repairs

The following repairs were made during the period of the tests:

5.7.1 Replacement of 30 bolts of 5/8 inch diameter connecting the floor plates of the vibrating discharge trough with the supporting beams.

5.7.2 Replacement of four conveyor pans which had been stripped off at the head end by tramp metal wedged between the pans and the take-up shaft.

5.7.3 Replacement of the steel strip closing the gap at the top of the conveyor pans. The strip had been torn loose by wire springs.

5.7.4 Replacement of the rubber curtain in the vibrating feeder trough. The curtain had been torn to pieces by heavy metal slugs or shrapnel.

5.7.5 Replacement of oil tubes connected with the hydraulic cylinder attached to impact plate above the rotor. An attempt was made to relieve a momentary blockage without stopping the machinery by increasing the clearance between the impact plate and rotor. This action was ineffective, since an oil tube was ruptured before the impact plate was raised.

6. COST ANALYSIS

Operating costs during testing are summarized in Table 8.7. Labor requirements for crushing either mixed bulk or incombustibles during testing was one crane operator and three laborers. Power requirements during the incombustible crushing test were higher than during the mixed bulk crushing test. The increased power requirement is caused by the greater resistance to crushing of the incombustibles compared to mixed bulk.

Tooth replacement and hard surface weld rebuilding of impact plate and tooth wear surfaces was not found necessary during the testing program. These costs are estimated to be $1,968.00 for 600 hours of operation corresponding to 6000 tons. This would add about 33¢ to the cost of each ton processed through the machine.

Operating costs during testing of mixed bulk of $3.25/ton is higher than would be expected during normal operations, because of down time due to jamming. Projected normal operating costs with jamming eliminated would reduce costs to $2.00/ton. If $1.00/ton is added for expendible crusher parts and crusher plant maintenance, projected as a recurrent expense in future plant operations, the total operating cost becomes $3.00/ton, as shown in Table 8.8.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Efficacy of Crushing Bulk Refuse

7.1.1 Bulk refuse crushing is valuable for both incineration and landfill for the City of Buffalo.

7.1.2 Crushing makes possible the incineration of the bulk fraction of solid wastes in modern three-level traveling grade continuous feed furnaces, of the type installed at Buffalo's West Side plant.

7.1.3 Crushing does not make possible the incineration of mixed bulk-fed refuse in batch-fed incinerators of the type installed at Buffalo's West Side plant, because of problems with spring wire and similar materials.

7.1.4 Crushing of incombustible bulk refuse reduced landfill requirements for bulk material by 46% (see Table 8.4).

7.1.5 Crushing plus incineration of mixed bulk refuse reduced landfill requirements for bulk materials by 89% (volume of uncrushed bulk minus residue volume) (see Table 8.6).

7.1.6 Crushing, followed by removal of the metal fraction and incineration of the remainder, reduced landfill requirements for bulk material by 96% (see Table 8.6).

7.2 Hazemag Crusher System Performance

7.2.1 All bulk materials required to be handled by the crusher unit were readily crushed. Carpets and tires are not readily crushed, but can be incinerated without prior processing. The overall performance of the unit will be satisfactory, with the changes made and indicated.

7.2.2 The Hazemag crusher has demonstrated the capability of handling Buffalo's mixed bulk refuse at a rate of 70 cubic yards per hour without plugging. 93% of the crushed incombustible bulk material by volume had a maximum dimension greater than 12 inches. The upper size limit of the crushed product is indeterminate being a function of the input material. Sheet metal from appliances are torn off in the crusher and can pass through with little size reduction and exit the machine having a maximum dimension as large as 6 feet. On the other hand, heavier gauge metals are crushed and mauled in the machine until reduced to a compact mass with one dimension as small as 8 inches on exit.

7.2.3 The unit is ruggedly built. Based on observations to date, it is reasonable to assign an equipment amortization life for the crusher in a range of 20 to 25 years, assuming proper operation and regular maintenance.

7.2.4 The striking faces of the rotor teeth have a useful life estimated at 600 hours. This replacement rate appears satisfactory for equipment of this type and service.

7.2.5 Equipment Recommendations

7.2.5.1 The 3/8" thick roof plate should be replaced or reinforced to adequately withstand bombardment from below by slugs struck by rotor.

7.2.5.2 Volume of the discharge chute under the crusher should be substantially increased to avoid clogging of the rotor.

7.2.5.3 The flexible curtain, to prevent shrapnel-like pieces from being ejected from the crusher, should be replaced by one better able to contain bombardment.

7.2.5.4 Operating noise levels should be checked. Any necessary mechanical or procedural changes necessary to obtain conformity with existing noise codes should be undertaken.

7.3 Operating Procedures

7.3.1 Estimated average bulk refuse collection for 1971 for the City of Buffalo is 2000 cubic yards per day. The crusher would have to be operated 8 hours per day, at the demonstrated rate of 70 cubic yards per hour to prepare 560 cubic yards of bulk material per day for incineration.

7.3.2 Refrigerators, mattresses, bed springs, and other items likely to cause plugging, should be set aside by the crane operator to be slowly charged at the end of the day's run when the crusher is empty. This should decrease down time (see Tables 8.2 and 8.3).

7.3.3 Formal training of personnel in the operation and maintenance of the crusher is mandatory.

7.3.4 Crushed mixed bulk charged to the incinerator should not exceed one third of the feed. The other two-thirds should consist of general refuse. Prior magnetic removal of ferrous metals from the crushed mixed bulk might make this combination unnecessary, in which event all crushed combustible bulk could be handled in either the old or new furnaces at Buffalo.

7.4 Metal Fraction Removal

7.4.1 Charging of large quantities of metals into the incinerator is undesirable. Combustion efficiency is reduced and results in avoidable wear and tear on furnace components.

7.4.2 Metals should be substantially removed from mixed bulk after crushing, but prior to incineration. Separation can be effected at the head end of the discharge conveyor with a magnetic separator. Metallic removal would enable the crushed bulk to be burned in the batch-fed furnaces, as well as the new continuous feed furnace.

7.4.3 Buffalo should seek a contract with a scrap metal dealer to remove the metal fraction for recycling. Pre-sized metal scrap is more salable than whole metal objects, but investigation is necessary to determine the most marketable sizes. Recycling of crushed metal would reduce the cost of haul and landfilling, as well as wear on the incinerator.

7.4.4 Significant dollar income from the sale of scrap is unlikely, because of current conditions in the ferrous scrap metal market. Recent pressures on scrap metal users to use more reclaimed metal may eventually result in increased scrap metal prices.

8. TABLES

TABLE 8.1

INCOMING MIXED BULK COMPOSITION
(MEASURED IN RECEIVING BIN - APRIL 19 - JUNE 3, 1971)

COMPONENT	VOLUME (CU. YDS.)	VOLUME (% TOTAL)
COMBUSTIBLE		
PAPER	1,179.7	23.0
WOOD PRODUCTS	2,179.8	42.5
TREE WASTE	871.9	17.0
TEXTILES	87.2	1.7
PLASTICS	41.0	0.8
TOTAL	4,359.6	85.0
NON-COMBUSTIBLE		
FERROUS METAL	692.4	13.5
NON-FERROUS METAL	30.8	0.6
CERAMIC AND GLASS	46.2	0.9
TOTAL	769.4	15.0
COMBINED TOTAL	5,129.0	100.0

AVERAGE DENSITY - 306 LBS./CU. YD.

BASED ON TOTAL MEASURED WEIGHT OF 785.0 TONS

TABLE 8.2

CRUSHER TEST RECORD - INCOMBUSTIBLES

TEST DATES 1971	AMOUNT CRUSHED TONS	AMOUNT CRUSHED CU.YDS.	DENSITY (AS RECEIVED) LBS/CU.YD.	OPERATING HOURS	DOWN TIME HOURS	TOTAL HOURS	RATE PER HR. (OVERALL HRS) TONS	RATE PER HR. (OVERALL HRS) CU.YDS.	RATE PER HR. (OPERATING HRS) TONS	RATE PER HR. (OPERATING HRS) CU.YDS.	ENERGY CONSUMPTION KWH PER TON	ENERGY CONSUMPTION KWH PER CU.YD.	HAMMER WEAR
JAN. 12 thru APRIL 8	59	434	274	10	0	10	6.04	44.2	Same	Same	30.2	4.1	See Dwg. 9.5
										TOTAL:	1780 KWH		

CRUSHER TEST RECORD - MIXED BULK

APRIL 19 thru JUNE 3	785	5129	306	72	55	127	6.2	40.4	11	71.5	10.04	1.54	See Dwg. 9.5
										TOTAL:	7900 KWH		
										COMBINED TOTAL:	9680 KWH (1)		

(1) A G.E. single phase amp. recorder was used to provide an indication of power drawn by the crusher. The chart shows maximum ampere requirements at startup, with a drop back to 200 amps. during normal operation at slightly above idling load. Difficult crushing material, on entering the machine, causes almost instantaneous current peaks which quickly drop back to normal levels. Most of the peaks are above 500 amps., with a maximum recorded at 1500 amps. A portion of the chart is shown as Chart 8.2.1.

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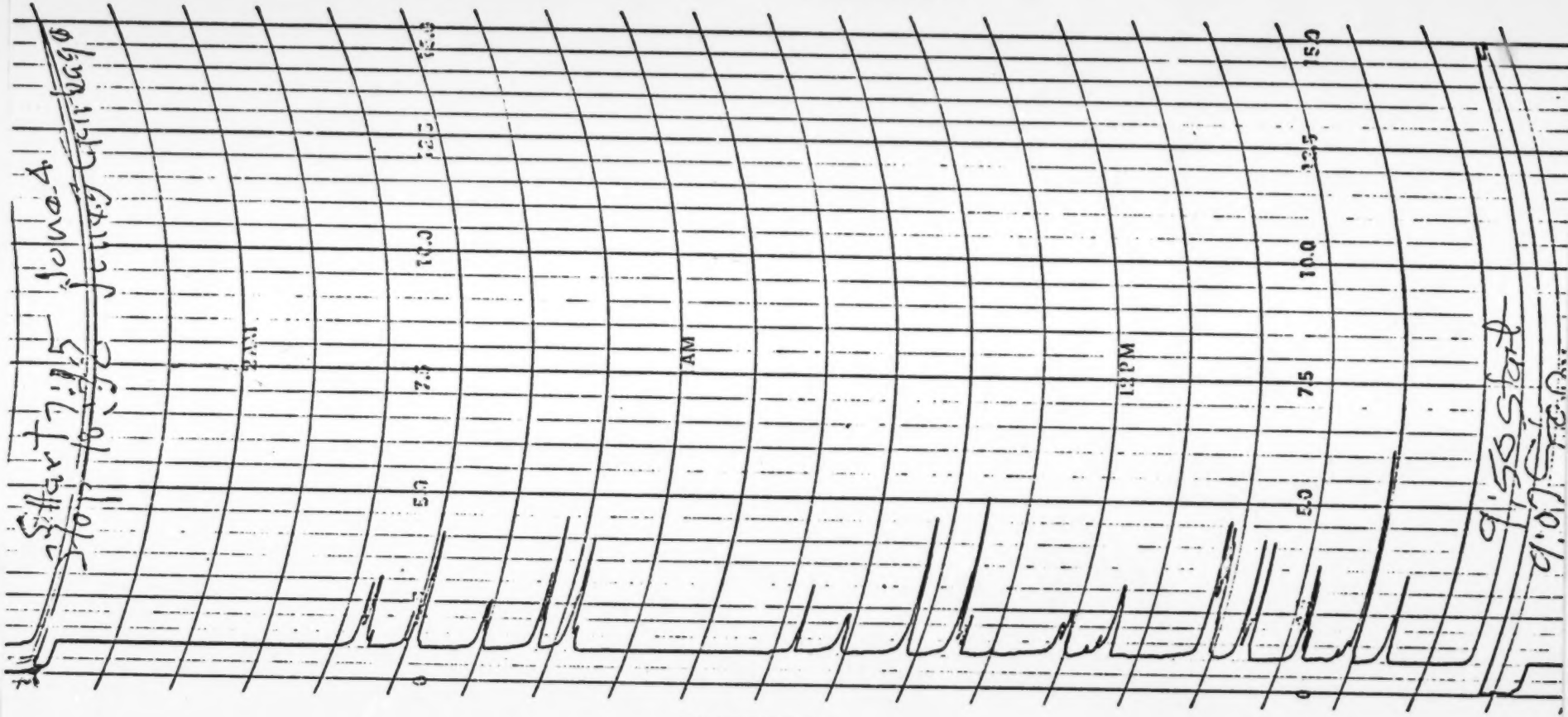


CHART 8.2.1

POWER CURVE FOR
9:50 AM - 10:30 AM TEST
JUNE 3, 1971

NOTE: Multiply Scale by Factor of (200) to read amps.

TABLE 8.3

CRUSHER TEST - DOWN-TIME ANALYSIS
JANUARY 12 - JUNE 3, 1971

STOPPAGE TYPE	FREQUENCY	DOWN-TIME TOTAL HRS.	DOWN-TIME AVERAGE
REFRIGERATORS JAMMED IN CRUSHER	14	21	1.5
BEDSPRINGS JAMMED IN CRUSHER	4	8	2
DISCHARGE CONVEYOR PANS DAMAGED	2	12	6
DISCHARGE CONVEYOR SKIRT DAMAGED	2	4	2
DISCHARGE CHUTE CLOGGED	1	8	8
RECEIVING BIN FIRE	2	2	1
TOTAL	25	55	

TOTAL TEST TIME - 127 HOURS

TABLE 8.4

CRUSHER TEST — BULK REDUCTION
JANUARY 12 - JUNE 3, 1971

BULK TYPE	WEIGHT (TONS)	VOLUME (CU. YDS.) BEFORE CRUSHING	VOLUME (CU. YDS.) CRUSHED	VOLUME REDUCTION %	DENSITY (LBS. PER CU. YD.) PRE-CRUSHED	DENSITY (LBS. PER CU. YD.) CRUSHED	DENSITY INCREASE %
INCOMBUSTIBLE	59	434	235	46	274	505	84
MIXED	735	4,779	3,068	36(1)	308	479	56

(1) 43% reduction when ferrous metals are removed after crushing.

TABLE 8.5

INCINERATOR RESIDUE ANALYSIS
CRUSHED MIXED BULK BY WEIGHT
AUGUST 30, 1971

COMPONENTS	FURNACE NO. 4 32# SAMPLE	FURNACE NO. 4 44# SAMPLE	FURNACE NO. 1 24# SAMPLE	FURNACE NO. 1 27# SAMPLE
METALS (Magnetic & Non-Magnetic)	48.95%	43.43%	14.08%	10.13%
NON-METALS (Broken Glass & Non-Fusible Material)	28%	37%	59%	60%
COMBUSTIBLE PORTION OF ASH	15.08%	8.65%	11.59%	8.49%
MOISTURE CONTENT	7.0%	10.5%	14.6%	21.1%

TABLE 8.6

INCINERATOR TEST - BULK REDUCTION
TRAVELING GRATE CONTINUOUS FEED FURNACE #4
JANUARY 12 - JUNE 3, 1971

	WEIGHT DATA		VOLUME DATA		DENSITY DATA	
CHARGE-CRUSHED MIXED BULK REFUSE	74.72 Tons		312 Cu Yd		479(2) Lbs/Cu Yd	
RESIDUE	DRY	WET	DRY	WET	DRY	WET
	47.77 Tons	52.35 Tons	54.57 Cu Yd	60 Cu Yd	1,751 Lbs/Cu Yd	1,745 Lbs/Cu Yd
REDUCTION AS % OF CHARGE - INCINERATION	36	30	82.5	80.8	366(3)	364(3)
TOTAL REDUCTION AS % OF RAW BULK - CRUSHING AND INCINERATION	36	30	89(1)	88	571(3)	571(3)

(1) 96% volume reduction when ferrous metals are removed after crushing.

(2) 308 Lbs/Cu Yd - Density before crushing (see Table 8.4).

(3) Increase as % of Charge Density.

TABLE 8.7

CRUSHER TEST - OPERATING COSTS[1]
JANUARY 12 - JUNE 3, 1971

	INCOMBUSTIBLE TEST 59 TONS 434 CU. YDS. 9.8 HOURS			MIXED BULK TEST 785 TONS 5,129 CU. YDS. 127 HOURS		
	PER HOUR	PER CU.YD.	PER TON	PER HOUR	PER CU.YD.	PER TON
LABOR @ $4.24/HR.	$12.72	$0.29	$2.11	$12.72	$0.315	$2.05
CRANE OPERATOR @ $5.07/HR.	$ 5.07	$0.11	$0.84	$ 5.07	$0.125	$0.82
POWER[2]	$ 5.73	$0.13	$0.96	$ 4.20	$0.059	$0.38
TOTAL UNIT OPERATING COSTS[1]	$23.52	$0.53	$3.91	$21.99	$0.499	$3.25
AMORTIZATION	$32.90	$0.75	$5.46	$32.90	$0.460	$2.99
TOTAL UNIT COSTS (INCLUDING AMORTIZATION)	$56.42	$1.28	$9.37	$54.89	$0.959	$6.24

(1) Incineration, crusher expendible materials and crusher plant maintenance not included.

(2) See Section 12, Power Calculations, Sheets 4 and 5 for unit power costs.

TABLE 8.8

CRUSHER-PROJECTED UNIT OPERATING COSTS INCLUDING AMORTIZATION[1]
8 HOUR DAY - 5 DAY WEEK

	INCOMBUSTIBLES			MIXED BULK		
	PER HOUR	PER CU.YD.	PER TON	PER HOUR	PER CU.YD.	PER TON
LABOR @ $4.24/HR.	$12.72	$0.29	$2.11	$12.72	$0.178	$1.16
CRANE OPERATOR @ $5.07/HR.	$ 5.07	$0.11	$0.84	$ 5.07	$0.071	$0.46
POWER[2]	$ 5.73	$0.13	$0.96	$ 4.20	$0.059	$0.38
CRUSHER PLANT MAINTENANCE	$ 4.03	$0.091	$0.67	$ 7.37	$0.103	$0.67
EXPENDABLE MATERIALS REPLACEMENT ($1,968.00 FOR 6000 TONS)	$ 1.99	$0.045	$0.33	$ 3.63	$0.051	$0.33
TOTAL UNIT OPERATING COSTS	$29.54	$0.666	$4.91	$32.99	$0.462	$3.00
UNIT AMORTIZED COST[3]	$32.90	$0.75	$5.46	$32.90	$0.460	$2.99
TOTAL UNIT COSTS	$62.44	$1.416	$10.37	$65.89	$0.922	$5.99

(1) Incineration not included. Based on elimination of crusher plugging and consequent downtime.

(2) See Section 12, Power Calculations, Sheets 4 and 5 for unit power costs.

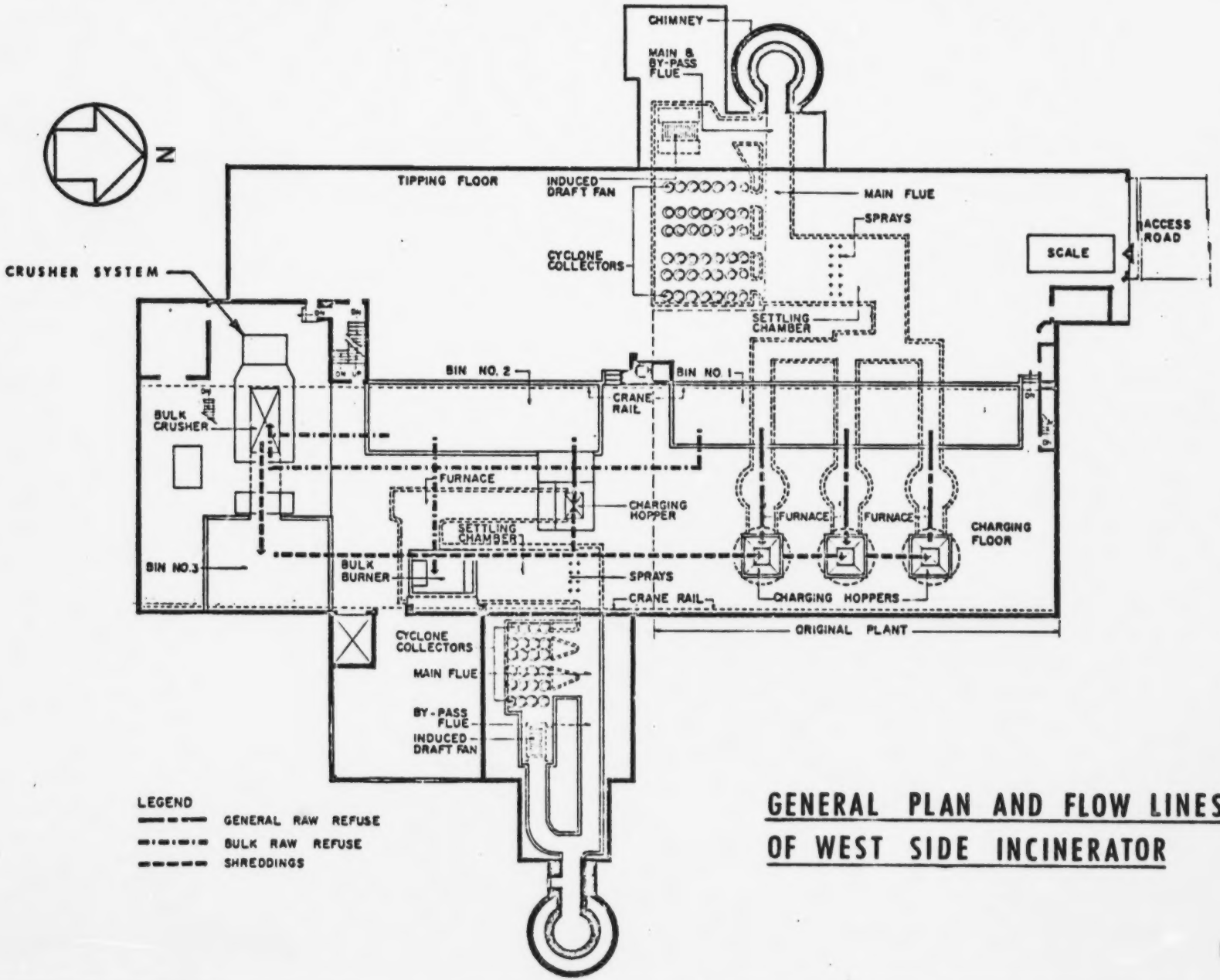
(3) See Table 8.9, for Capital Costs and Amortization.

TABLE 8.9

CAPITAL COSTS AND AMORTIZATION

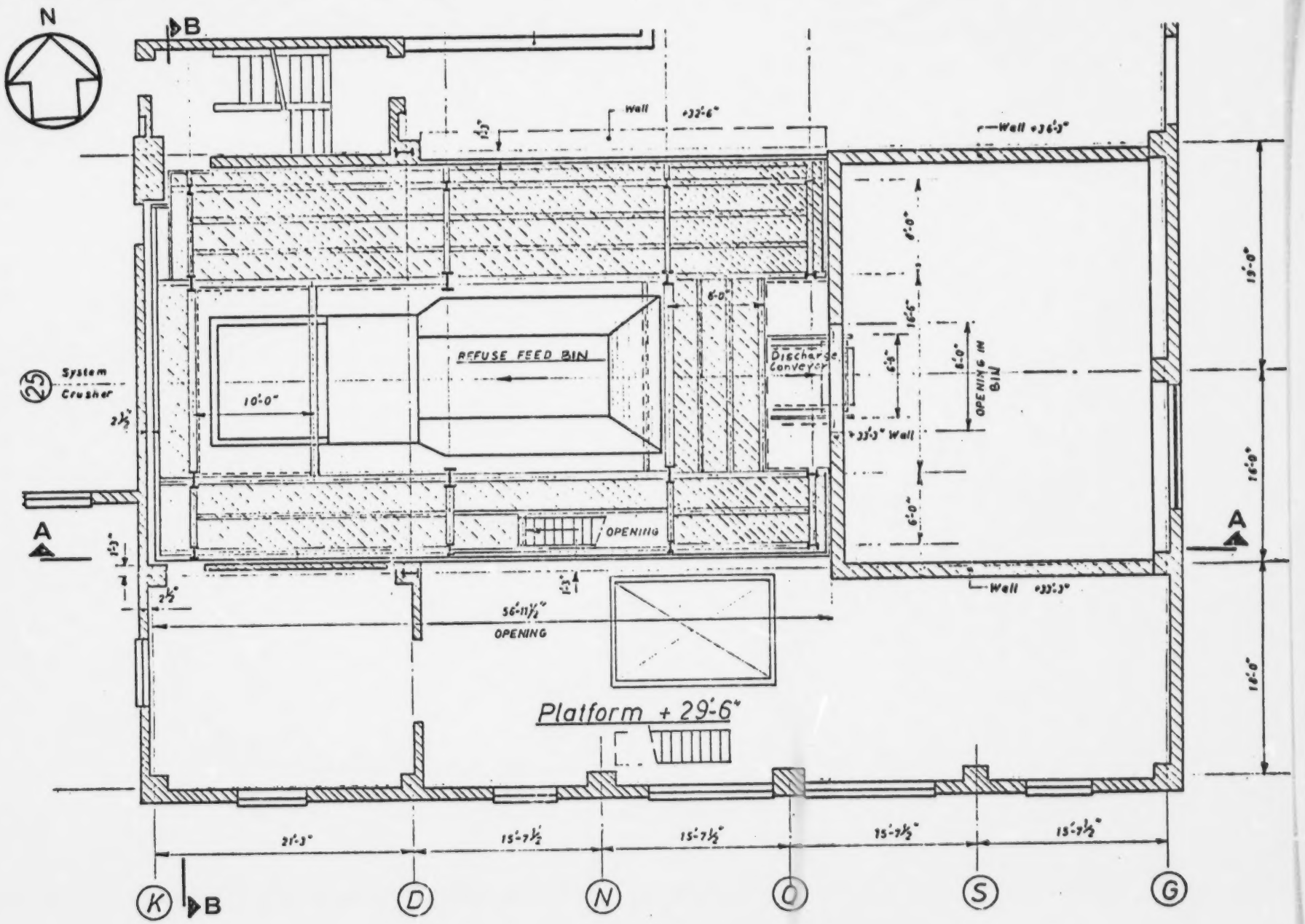
I Construction Costs		
1. General Contractor	$265,000	
2. Incinerator Contractor	409,800	
3. H & V Contractor	2,000	
4. Plumbing Contractor	3,477	
5. Electrical Contractor	34,600	
Total Construction Costs		$714,877
II Engineering & Construction Contract Administrative Costs		$ 71,487
TOTAL CAPITAL COST		$786,364
ANNUAL CAPITAL COST Amortized @ 6% interest, 20 year payout (Capital Recovery factor = .0872)		$ 68,500
UNIT AMORTIZED COST PER HOUR (2080 HRS/YR)		$32.90
UNIT AMORTIZED COST PER TON OF MIXED BULK (22,880 T/YR)		$ 2.99
UNIT AMORTIZED COST PER CU.YD. OF MIXED BULK (148,500 CY/YR)		$ 0.46
UNIT AMORTIZED COST PER TON OF INCOMBUSTIBLES (12,550 T/YR)		$ 5.46
UNIT AMORTIZED COST PER CU.YD. OF INCOMBUSTIBLES (92,000 CY/YR)		$ 0.75

9. DRAWINGS AND DIAGRAMS



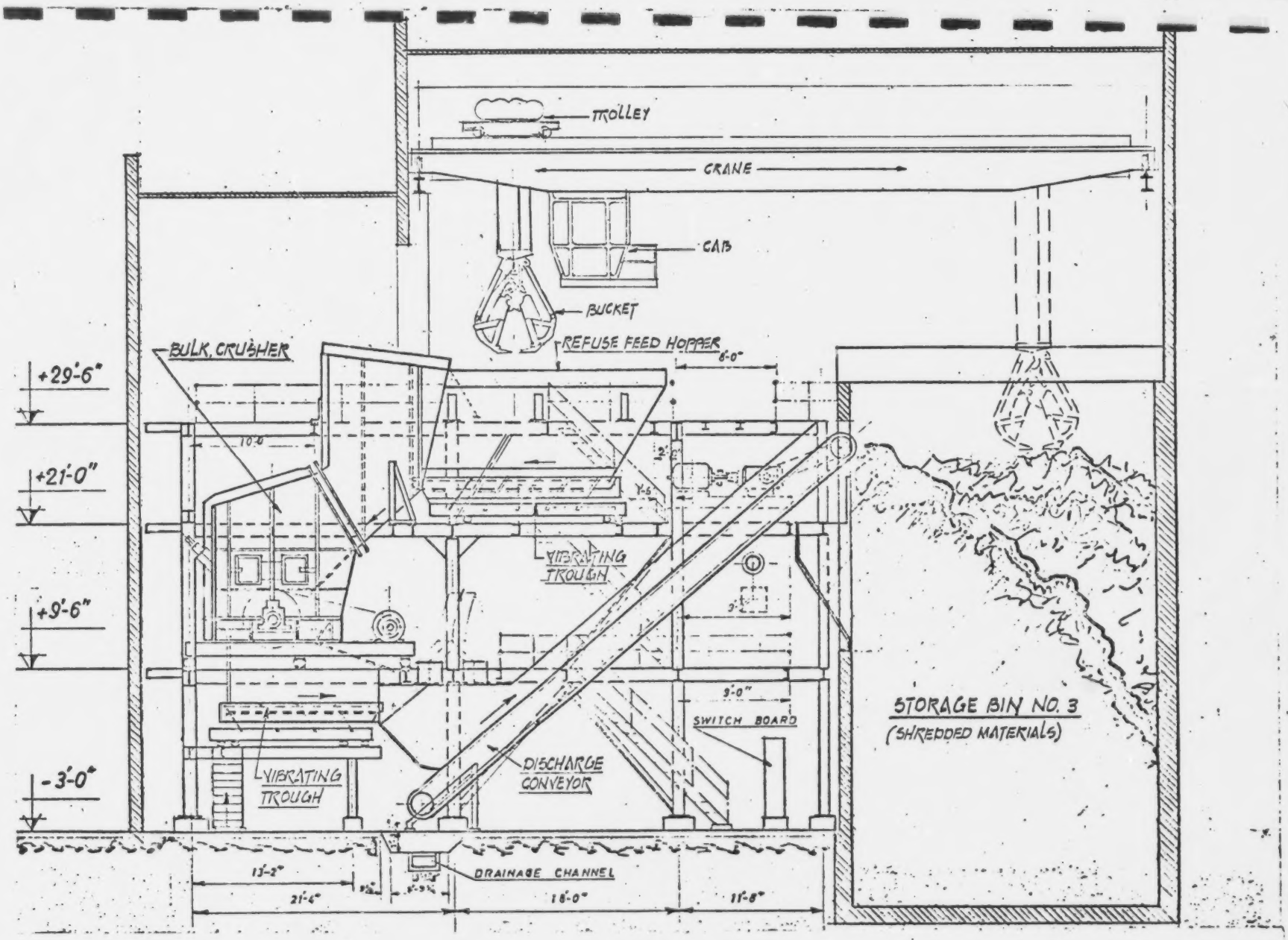
GENERAL PLAN AND FLOW LINES OF WEST SIDE INCINERATOR

DWG. 9.1



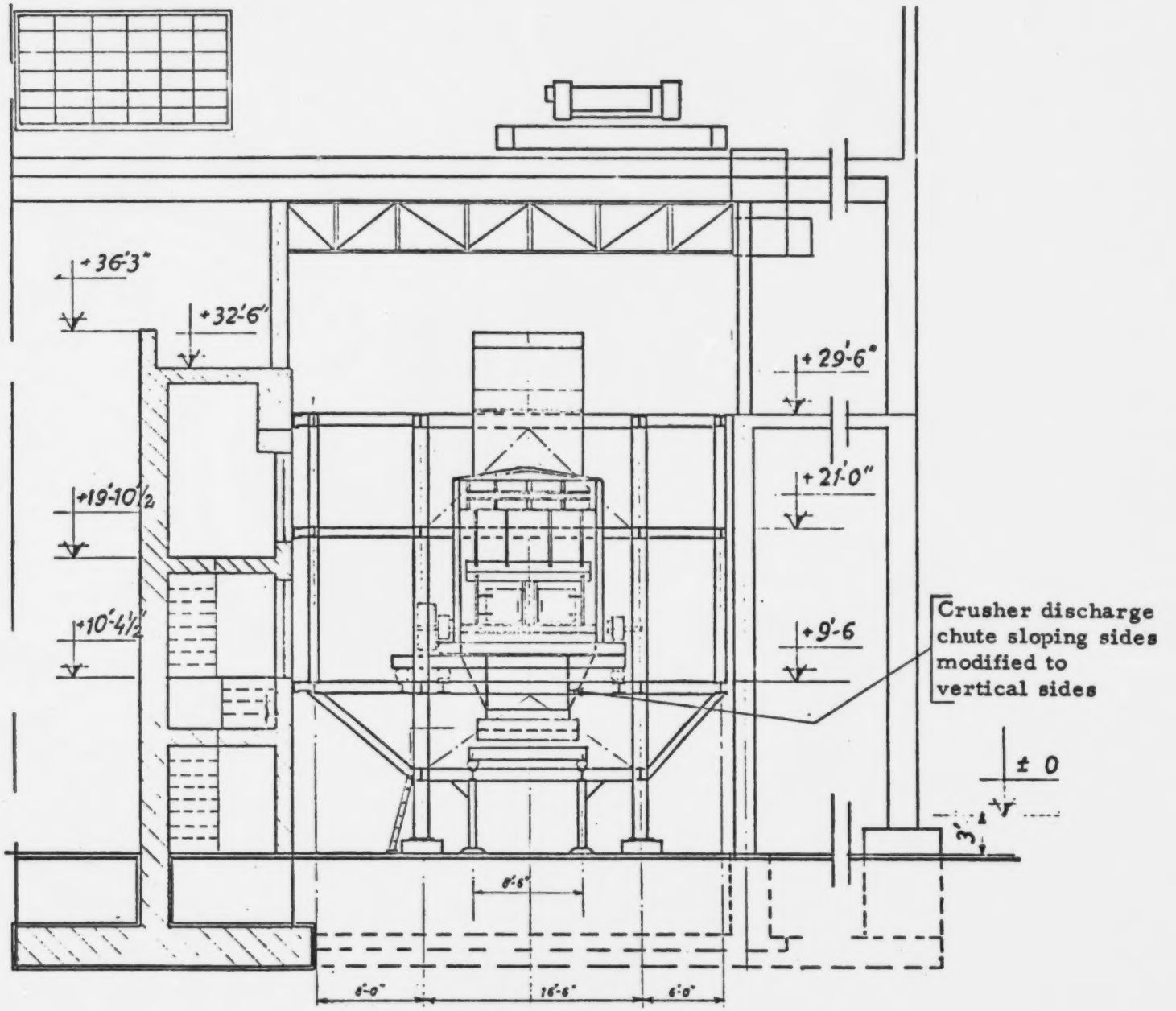
PLAN OF CRUSHER SYSTEM

DWG. 9.2



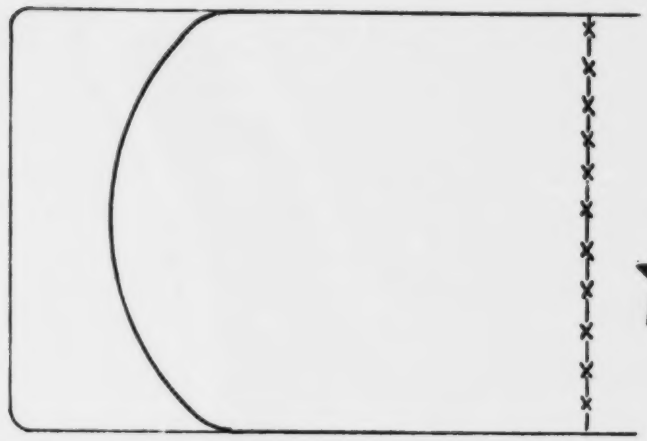
SECTION A-A

DWG. 9.3

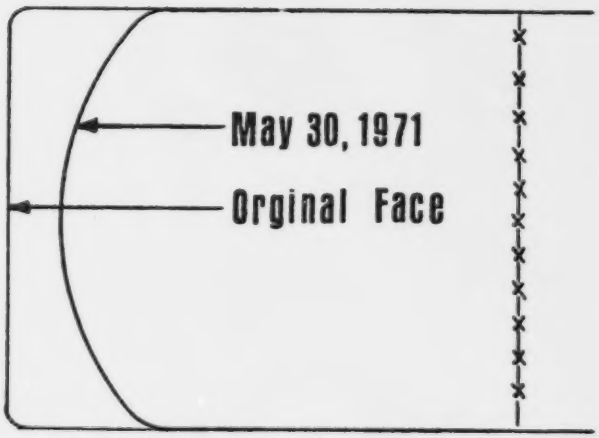


SECTION B-B

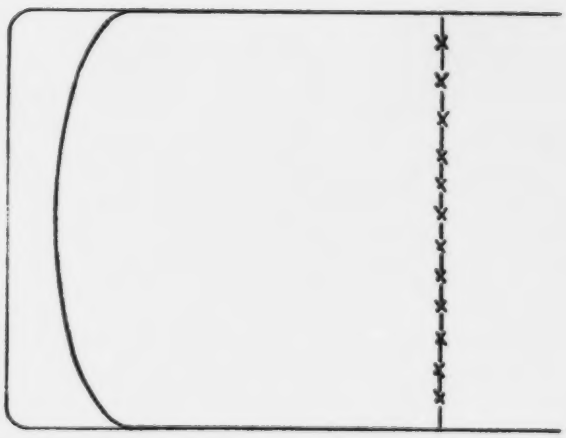
DWG. 9.4



SECTION A–A



SECTION B–B



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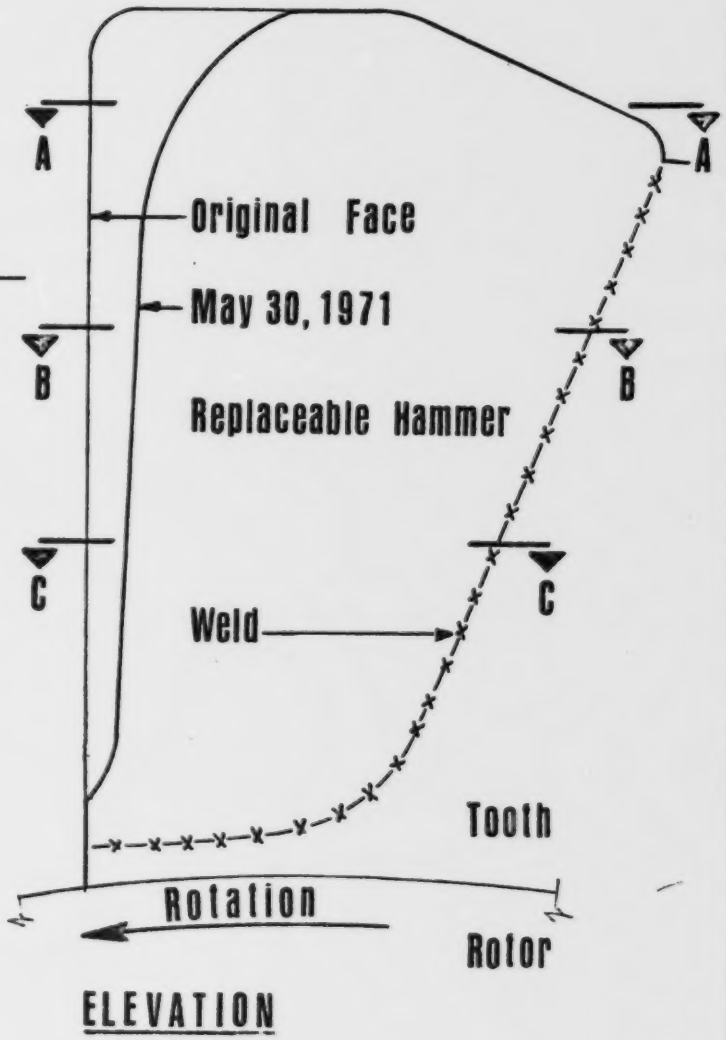


ELEVATION

ELEVATION & SECTIONS SHOWING WEAR ON TEETH OF HAZEMAG CRUSHER

Scale: Full Size

DWG. 9.5

10. WITNESS TEST REPORT

January 5, 1968

HAZEMAG ROTARY IMPACT CRUSHER

REPORT ON EUROPEAN PROTOTYPE OPERATION, WITNESS TESTS AND ADAPTABILITY FOR SERVICE AT BUFFALO WEST SIDE INCINERATOR PROJECT

WITNESS TEST

Witness tests are based on actual operating performance and are utilized to determine whether the unit proposed by the contractor meets the purpose and intent of the specifications.

PLACE OF TESTS

Hamburg, West Germany	December 6, 1967
Lengerich, West Germany	December 7, 1967
Amsterdam, Holland	December 8, 1967

INSPECTION PARTY

Commissioner John F. Downing, Dept. of Public Works, City of Buffalo, N. Y.

Mr. Herbert Mandelbaum, Leonard S. Wegman Co.

Mr. Roger G. Burns, Leonard S. Wegman Co.

ARRANGEMENTS

Herr A. J. Kraus, Export Manager for Hazemag m.b.H., made arrangements for the testing and served as guide for the party.

Crusher Unit

The Hazemag crusher installation at Hamburg utilizes their current model SAP5M, the same type and size rotary impact crusher proposed for Buffalo. (At Hamburg the crusher drive motor is rated 288 hp, whereas the Buffalo unit will have a 400 hp motor.)

Loading

Bulky refuse is normally dumped from a truck into a skip hoist bucket which raises the material and discharges into a vibrating pan feed conveyor. The conveyor then moves the bulk objects into the crusher. The crushings discharge on to another vibrating pan conveyor which in turn empties on to a ribbed belt conveyor which then transports the crushings to storage and ultimate incineration. An alternate means of charging bulk objects uses an adjoining crane and grapple system. This loads directly into the feed conveyor, bypassing the skip hoist.

The skip hoist method of loading presented some difficulty. As bulk objects emptied from the skip hoist bucket into the feed conveyor, material jammed against the sides of the pan conveyor. An attendant had to rod the bulk objects to free them for vibrating conveyance into the crusher.

(At Buffalo the skip hoist method of loading is not used. Bulk objects there will be loaded from the receiving bin directly by overhead crane and grapple into the vibrating feeder conveyor.)

Rubber Joint

A flexible rubber joint is used between the vibrating feed conveyor and the crusher entrance section. The rubber had worn through providing a gap for the material to fall through. Herr Sander, Chief Engineer for Hazemag, was advised to correct this detail for Buffalo. (We reviewed and discussed a proposed modification at our meeting at Hazemag's main office in Münster on Dec. 7, 1967. This modification will consist of an additional deflection plate. This has been detailed for our approval.)

The following summarizes the 4 test runs:

Test 1 @ 11:20 AM

Raw Material

Bulk Objects	Dimensions (ft)	Volume (cf)	
1 Refrigerator	3.3 x 2.6 x 2.6	22.3	
2 Sofas	ea. 6.6 x 3.3 x 2.6	113.0	
1 Stove	2.6 x 3.9 x 2.0	20.2	
1 Bicycle	5.9 x 0.1 x 2.6	1.5	
2 Arm Chairs	ea. 2.6 x 2.0 x 3.3	34.2	
2 Tree Trunks	ea. 1.0 dia. x 6.6 lg.	10.4	
		201.6	(Net)
		303.0	(Gross - incl. 50% swell Facto

Reduction

These objects were reduced to the following sizes:

50% - 2 to 4 inches in diameter, 4 to 6 inches long
50% - up to about 1 inch in diameter, 2 to 4 inches long

Appearance

Friable material such as the wood in chairs and tree trunks tended to splinter; the soft material in the sofas and arm chairs were more or less shredded. The metal refrigerator and stove were crushed into compact shapes.

Amperage

Current readings for the crusher motor were:

When empty	170 amps
When crushing	220 amps for 10 sec.
	200 amps for 10 sec.
	190 amps for 10 sec.
	180 amps for 30 sec.
	170 amps for 30 sec.

At a power factor of 0.85* and voltage of 380 volts, maximum KW input = 123, corresponding to 165 hp.

Crushing Rate

Total crushing time: 90 sec. for a gross volume of 303 cf, as charged.

Crushing rate = 202 cf/min.
= 12120 cf/hr.
= 450 cy/hr.

Test 2 @ 11:30 AM

Raw Material

Bulk Objects		Dimensions (ft)	Volume (cf)
2 Tree Trunks	ea.	2.0 dia. x 4.0 lg.	25.2
2 Tree Trunks	ea.	2.1 dia. x 5.9 lg.	40.7
2 Tree Trunks	ea.	1.0 dia. x 4.9 lg.	7.8
1 Tree Trunk		2.2 dia. x 3.0 lg.	11.4
			85.1 (Net)
			127. (Gross)

Reduction

These objects were reduced as follows:

50% - 2 to 3 inches in diameter, 6 to 8 inches long
50% - up to about 1 inch in diameter, 1-1/2 to 4 inches long

Amperage

Current readings on crusher motor:

When empty	170 amps
When crushing	300 amps for 10 secs.
	200 amps for 10 secs.
	180 amps for 60 secs.

At a power factor of 0.85* and voltage of 380 volts, maximum KW input = 167, corresponding to 224 hp.

*Estimated

Test 2 @ 11:30 AM (cont'd)

Crushing Rate

Total crushing time: 90 sec/ for a volume of 127 cf

Crushing rate = 85 cf/min.
= 5100 cf/hr.
= 189 cy/hr.

Test 3 @ 11:50 AM

Raw Material

Bulk Objects		Dimensions (ft)	Volume (cf)
3 Tree Trunks	ea.	1.1 dia. x 3.3 lg.	9.4
1 Sofa		6.5 x 3.3 x 2.6	55.8
2 Arm Chairs	ea.	2.6 x 2.0 x 3.3	34.2
3 Mattresses	ea.	6.6 x 1.0 x 3.3	65.4
1 Stove		2.6 x 4.0 x 2.0	20.8
2 Doors	ea.	6.5 x .3 x 3.1	12.0
4 Cabinets	ea.	3.3 x 1.7 x 3.3	74.0
			271.6 (Net)
			406. (Gross)

Reduction

Size reduction through crusher was similar to Tests 1 and 2.

Amperage

Current readings on crusher moter as follows:

When empty	170 amps
When crushing	200 amps for 30 sec.
	180 amps for 40 sec.
	170 amps for 110 sec.

At a power factor of 0.85* and voltage of 380 volts, maximum KW input = 112 corresponding to 150 hp.

*Estimated

Test 3 @ 11:50 AM (cont'd)

Crushing Rate

Total crushing time: 3 min. for a volume of 406 cf

Crushing rate = 135 cf/min.
= 8100 cf/hr.
= 300 cy/hr.

Test 4 @ 12:10 AM

Raw Material

Bulk Objects	Dimensions (ft)	Volume (cf)
4 Tree Trunks	ea. 2.6 dia. x 3.9 lg.	83.0
4 Tree Trunks	ea. 2.0 dia. x 4.9 lg.	61.6
4 Tree Trunks	ea. 1.6 dia. x 3.3 lg.	26.5
4 Tree Trunks	ea. 1.3 dia. x 3.6 lg.	19.1
		190.2 (Net)
		285. (Gross)

Reduction

Size reduction through crusher was similar to Test 2.

Amperage

Current readings on crusher motor as follows:

When empty	170 amps
When crushing	500 amps for 10 sec.
	800 amps for 1 sec.
	800 amps for 1 sec.
	450 amps for 10 sec.
	380 amps for 10 sec.
	200 amps for 20 sec.
	180 amps for 40 sec.
	170 amps for 60 sec.

At a power factor of 0.85* and voltage of 380 volts, maximum KW input = 447 corresponding to 600 hp, which load persisted for only 2 seconds. The load corresponding to the 500 ampere reading which was sustained for 10 seconds amounted to 279 KW, 374 hp.

Crushing Rate

Total crushing time: 152 sec for a volume of 285 cf.

Crushing rate = 113 cf/min
= 6800 cf/hr
= 252 cy/hr

Average Crushing Rate

Test 1 - 450 cy/hr
2 - 189 cy/hr
3 - 300 cy/hr
4 - 252 cy/hr
1191 cy/hr
Avg. = 297 cy/hr

A 1 ft. wide x 6.5 ft. long carpet was included in Test 4. The carpet was not seen coming out of the crusher, apparently obscured by the other material being simultaneously discharged. After the test run, the interior of the crusher was inspected to determine if the carpet had wrapped itself around the rotor. No trace of the carpet was found within the machine.

LENGERICH, GERMANY Dec. 7, 1967

The Hazemag facility at Lengerich is an outdoor, semi-portable installation utilizing a smaller crusher having a rated throughput of approximately one-half of the Hamburg unit. The unit is designated their Model AP4/80M.

*Estimated

LENGERICH, GERMANY (cont'd) Dec. 7, 1967

Several lightweight carpets, approximately 10 foot square, were each folded over once and then fed into the crusher. The crusher passed the carpets, only tearing them slightly.

The purpose of the test was to ascertain if carpets would pass through the crusher or if they would wrap themselves around the rotor of the crusher and thereby foul the rotor. As demonstrated, the crusher passed the carpets.

Two tires were also fed into the crusher. Here again, little shredding was done to the tires other than some slight tears.

AMSTERDAM, NETHERLANDS Dec. 8, 1967

The Hazemag crusher facility at the old incinerator plant at Amsterdam is one of the original SAP5M models installed June, 1962. Mr. Van Slass of the Amsterdam plant advised that the unit operates 6 days per week, 24 hours a day handling pallets, furniture, harbor debris, timber and cartons, along with domestic refuse. The crushed material is then conveyed into the old plant, whose furnaces were constructed in 1916, and is incinerated there. Mr. Van Slass expressed his satisfaction with the equipment. He advised that the blow bars of the crusher rotor require refacing twice a year.

The crusher was observed in operation for about 1 hour and performed satisfactorily. (The same unit was observed by Mr. L. S. Wegman in Jan. 1965 and he reported similar satisfactory performance).

Comments

The simple, rugged, impact rotor design of the Hazemag unit provides a machine uniquely equipped to process otherwise difficult bulk refuse objects requiring size reduction in municipal incinerator and refuse service. This includes demolition lumber, tree trunks, furniture, bicycles, refrigerators and stoves. As observed, the unit is not effective in size reduction of carpets and tires. However, this limitation on the unit is judged as minor compared to the superior advantages cited for the machine in its performace on both the truly difficult and the majority of bulk refuse items. It will be noted that tires and carpets will be handled quite satisfactorily, without prior shredding, in both existing and new incinerators at Squaw Island.

Conclusions

The Hazemag crusher is very effective in reducing:

(a) Tree Trunks (30" diam. x 4'-0" long)
(b) Furniture (Sofas, Arm Chairs, Chests)
(c) Demolition Lumber (various sizes to about 6'-0" long)

which, except for furniture stuffing, passed out of the machine in small splinters, generally from about 1/4" to 4" in diameter by 2" to 6" long. Furniture stuffing passed out in clusters.

It is reasonably effective in reducing metal objects, such as:

(a) Bicycles
(b) Stoves
(c) Refrigerators

which passed out of the machine crushed into twisted and compact shapes.

It is not too effective in reducing:

(a) Tires
(b) Carpets

which suffered little damage after passing through the machine - but did, in no way, interfere with the machine's operation.

The witness tests of the Hazemag crusher operations at Hamburg, Lengerich and Amsterdam show that, with minor exceptions, it meets the contract specifications. The addition of a 400 hp motor in lieu of the 300 hp specified, the improvement in the feed to crusher joint and installation of an automatic fire prevention sprinkler along the discharge conveyor, all without additional cost to the City, is considered to more than compensate for the minor exceptions. The unit is accordingly approved for installation at Buffalo. (Acceptance tests will be made as called for in the contract documents when installation is completed.)

LEONARD S. WEGMAN CO.

By _____
Herbert Mandelbaum

By _____
Roger G. Burns

Date: Jan 15, 1968

11. MANUFACTURER'S SPECIFICATION DATA

11. MANUFACTURER'S SPECIFICATION DATA

A) General

Capacity of Plant: 260 cu. yds/hr bulk refuse

Crusher Type: Hazemag Impact Crusher SAP 5/M

1) The feed hopper has an opening of 15'-9" long, 16'-4-7/8" wide and 8'-10" deep, with a capacity of 1765 cu. ft. The floor plates and wear plates are manufactured of 0.4 inch Corten plate. The walls are braced with ribs against bending and twisting. The connecting inlet hood, of inner width 9'-8-1/2", 15'-9" high and 6'-6-3/4" long is fitted with a chain curtain and a rubber apron which permit easy entry of the bulky refuse, and at the same time protects against any crushed components flying back out of the impact crusher.

2) A vibratory pan feed conveyor, 7'-2-5/8" wide x 19'-8-7/32" long with a capacity of 314 cu. yds/hr, conveys the bulk refuse to the impact crusher.

Even with intermittent feeding by crane grapple, the pan conveyor enables a continuous feed to the impactor.

3) The direct inlet to the SAP 5/M impact crusher has an opening of 10'-0" wide and 5'-0" high.

The actual weight of the impactor, without motor but with drive frame, is 52 tons.

The machine is designed for a capacity of 260 cu. yds/hr, and has a drive system consisting of a 400 hp, 1175 rpm motor, V-belt and fluid coupling.

The drive frame is mounted on vibration eliminators, the crusher and the drive are on a common frame. The dynamic forces are absorbed by the vibration eliminators.

A hydraulic lifting unit on the first impact arm enables the gap setting between rotor and impact arm to be widened. The hydraulic unit is operated by a hand pump.

4) The crushed refuse passes via a discharge chute and the vibratory pan discharge conveyor under it to the inclined apron conveyor.

The discharge conveyor is 7'-2-5/8" wide and 14'-1-1/4" long. The floor plates are manufactured of heavy-duty Corten plate with reinforcing.

The crushed material is conveyed in the direction corresponding to the rotational direction.

5) The inclined apron conveyor, with round-link chain, conveys the crushed bulk refuse to the crushed bulk refuse storage bin.

The apron conveyor width is 5'-3" and the height is 12-9/16"; the speed is 55 ft/min.

Flights are fitted on to the pans of the apron conveyor so that the material is transported evenly to the storage bin.

The apron conveyor is designed for a capacity of 300 - 420 cu. yds/hr.

6) Dust control

A double cyclone, type ZV 10604/2 is installed for dust control. A main suction point is fitted at the inlet to the apron conveyor. After collection in the cyclones, the dust is passed via a discharge hopper common to both cyclones to a double pendulum flap gate, size 9-27/32" x 13-3/4", complete with gear motor arranged for discharge into a portable container.

The fan, which draws suction on the dust control cyclones is a type StR450 sp, single inlet, designed for a capacity of 10,500 cfm.

The exhaust air is ducted outside of the building for discharge to atmosphere.

7) Siftings

Siftings under the apron conveyor are collected in a tank.

8) Water spray unit

Above the inclined apron conveyor, a water spray unit with temperature control is provided.

Should the danger of fire occur and the room temperature exceed the set temperature (about 104 F), then the valve in the control plant opens automatically, and sprays water on to the crushed refuse.

The entire plant is erected on heavy-duty sectional steel girders. Stairs and platforms are covered with checker plate and the platform plating is welded to the girders.

B) Description of the Impact Crusher

The housing is divided into an upper and a lower part for reasons of assembly, these two parts also being subdividable into several parts. All housing and rotor parts are manufactured from welded open hearth steel plates and channel iron.

The impact plates, rake and wear plates consist of high quality, wear resisting steel which, when they are worn, are easily replaced.

The rotor consists of the rotor body and the shaft, which is mounted in 2 heavy-duty self-aligning roller bearings, the housings of which are mounted on the lower part of the impactor housing.

The impact arms are suspended in the upper housing and are adjustable by spindles from outside. The gap between the rotor teeth or blow bars and the lined impact arms suspended in the upper housing are adjustable and influence the degree to which the material is crushed.

C) Drive for SAP 5/M Impactor

The rotor in the impact crusher is driven by a squirrel-cage induction motor via Voith turbo fluid coupling and narrow V-belts. The fluid coupling is connected between the rotor shaft and motor shaft with flexible couplings. The hydro-dynamic coupling slip brings the motor very rapidly to operational speed. Furthermore, the transmission of torsional vibration and shocks is absorbed.

The drive described above is mounted on a welded, channel iron base frame. Two pedestals with thrust bolts have been fitted on the base plate on both sides of the frame. The entire base frame can be moved and through this, belt tensioning can be regulated.

Voith turbo coupling is built in coupling size 750 TV with flexible rubber pad couplings.

D) Spring Elements (Type DK)

The spring element is the elastic link between the base of the machine and the foundation.

The spring elements are not bolted either to the base or the foundation but are fitted with self-adhesive plates top and bottom.

E) Vibration Dampers (Type D)

Sleeve-type rag bolts and templates are used for fastening the dampers.

After removing the shuttering and fitting the spring elements, the vibration dampers are installed.

Between concrete and vibration dampers the levelling plates are put in. When fitting the dampers it is necessary to make sure that housing and plunger are dry and clean. The housing is then filled with the damping compound to 30 mm below the upper rim. In order to liquify the damping compound it must be heated to approx. 80 - 100 C. The compound is inflammable and must not be exposed to naked lights.

After the compound has cooled (this takes approx. 24 hours) the vibration dampers are ready for use.

F) Overall Dimensions and Data

Overall Length:	14'-5-1/4" Approx.
Overall Width:	16'-7-1/2" "
Height:	14'-5-1/4" "
Rotor Diameter:	5'-4-1/2" "
Weight of Crusher and Rotor:	53.58 Tons
Speed:	423 RPM
Driven Pulley Effective Diameter:	3'-8-3/32"
Capacity:	260 cu. yds/hr = 55 tons/hr
Size of Pieces:	78.7" x 39.3" x 31.5"
Drive:	3.93" ø Shaft with "Voith" Turbo Coupling and 12.99" diameter drive pulley
Voith Coupling:	Size 5G2 Tvl with Rubber Coupling Size 300 - Oil Volume: 7.26 gallons
Slip:	3.3% Approx.
Wedge Straps:	12 Pieces Profile SPC x 7500L
Short Time Overload:	50%
Rotor Velocity:	116.5 ft/sec.
Cylindrical Roller Diameter:	4'-3-3/16"

Maximum Crushing Gap Adjustment = 3.93"
Minimum " " " = 2.36"

Third Revised Leaf No. 84
Superseding Second " Leaf No. 84

SERVICE CLASSIFICATION NO. 3

LARGE GENERAL SERVICE

APPLICABLE TO USE OF SERVICE FOR:

All purposes required by customer on the premises for which no other service classification is specifically provided and where such entire requirements are delivered at one point and singly metered with respect to the delivery voltage. Available throughout the Company's service area from existing circuits of adequate capacity and appropriate character. Written application upon Company's prescribed forms is required and riders, whenever applicable, shall be attached.

CHARACTER OF SERVICE:

Continuous. Single or three phase alternating current, approximately 60 cycles, at one standard secondary voltage, or a primary distribution voltage or a transmission voltage. Company will indicate the voltage and type of service available and appropriate for the customer's requirements.

THIRTY DAY NET RATE:

Demand Charge:

$59.00 for the first 25 or less kilowatts of Demand
2.05 for each of the next 175 kilowatts of Demand
1.69 for each additional kilowatt of Demand

Plus Reactive Demand Charge:

$0.28 for each kilovolt-ampere of lagging Reactive Demand

Plus Energy Charge:

1.87¢ per kilowatthour for the first 14,000 kilowatthours
0.69¢ per kilowatthour for the remainder, if any, of the first 350 kilowatthours per kilowatt of Demand
0.46¢ per kilowatthour for all additional energy

RECEIVED
JUL 10 1972
LEONARD S. WEGMAN CO. INC.
ENGINEERS

Effective January 10, 1972 under authority of Public Service Commission, State of New York, Special Permission Order No. EL-1455, dated January 6, 1972.

Date of issue December 29, 1971 Date effective January 28, 1972

Issued by J. A. O'Neill, President, Syracuse, N. Y.

SERVICE CLASSIFICATION NO. 3 (Continued)

THIRTY DAY NET MINIMUM CHARGE:

The minimum monthly charge is the charge computed under RATE, the Demand being determined in accordance with the provisions included under Determination of Demand.

COST OF FUEL ADJUSTMENT:

The energy charges set forth herein shall be increased or decreased whenever the average cost of fuel in Company's operating fossil fuel electric generating stations increases or decreases from a base cost of 29.75 cents per million btu, as described on Leaves Nos. 55, 56 and 57.

DETERMINATION OF DEMAND:

A. The Demand shall be the highest average kilowatts measured in a fifteen minute interval during the month, but not less than three-quarters of the highest such Demand occurring during any of the preceding eleven months, nor less than the Demand contracted for.

B. The Reactive Demand shall be the highest average kilovolt-amperes of lagging reactive demand measured in a fifteen minute interval during the month less one-third of the highest kilowatt demand measured during the month. The Reactive Demand shall be determined when Customer's kilowatt demand has exceeded 150 kilowatts for three consecutive months or when the connected load of Customer indicates that the kilowatt demand may normally exceed 150 kilowatts. Reactive Demand determination shall continue until the kilowatt demand has been less than 150 kilowatts for twelve consecutive months.

HIGH VOLTAGE SERVICE:

When Customer provides all equipment required to take service at a primary distribution voltage or transmission voltage designated by Company, the demand charge stated under RATE shall be modified as follows:

(a) between 2200 and 15,000 volts, the stated demand charge less 20¢ per KW of demand billed

(b) between 22,000 and 50,000 volts, the stated demand charge less 33¢ per KW of demand billed

(c) above 60,000 volts, the stated demand charge less 40¢ per KW of demand billed

SERVICE CLASSIFICATION NO. 3 (Continued)

TERMS OF PAYMENT:

Bills are due when rendered and Customer is in default unless payment is made within ten days thereafter.

TERM:

One year from commencement of service under this Service Classification or under a Service Classification superseded hereby, and continuously thereafter until permanently cancelled by Customer upon ninety days' prior written notice to Company. Cancellation by Customer followed by resumption of service at the same location within one year shall not modify in any way the Determination of Demand as above provided

When the amount of investment by Company or other conditions of the service are such as to warrant, Company may, with the permission of Public Service Commission, require that the initial term be longer than one year and for successive one year terms thereafter until cancelled effective at the expiration of the initial term, or of any succeeding one year term, by Customer giving ninety days' prior written notice to Company.

SPECIAL PROVISIONS:

A. Standby service at 60 cycles may be obtained under this Service Classification upon written application and agreement as to minimum monthly charge based on Contract Demand as provided in Rule 12 of General Information.

B. When Company, pursuant to Rule 25.7.3, has provided total service at Customer's single location through more than one feeder, the quantities derived from all necessary meters will be combined for billing purposes in accordance with the provisions of such Rule upon the execution of the Rider for Combined Metering and Billing, attached to Form C.

C. When service is metered at a voltage either higher or lower than the voltage of delivery, metered quantities will be adjusted for billing as provided in Rule 25.8 of General Information.

Date of issue September 26, 1969 Date effective October 27, 1969

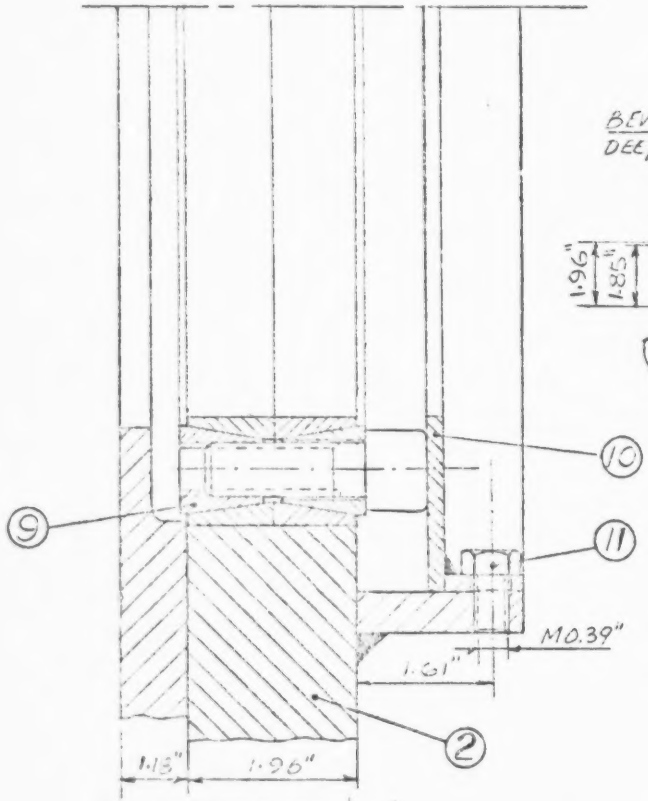
Issued by J. A. O'Neill, President, Syracuse, N. Y.

SERVICE CLASSIFICATION NO. 3 (Continued)

SPECIAL PROVISIONS: (Continued)

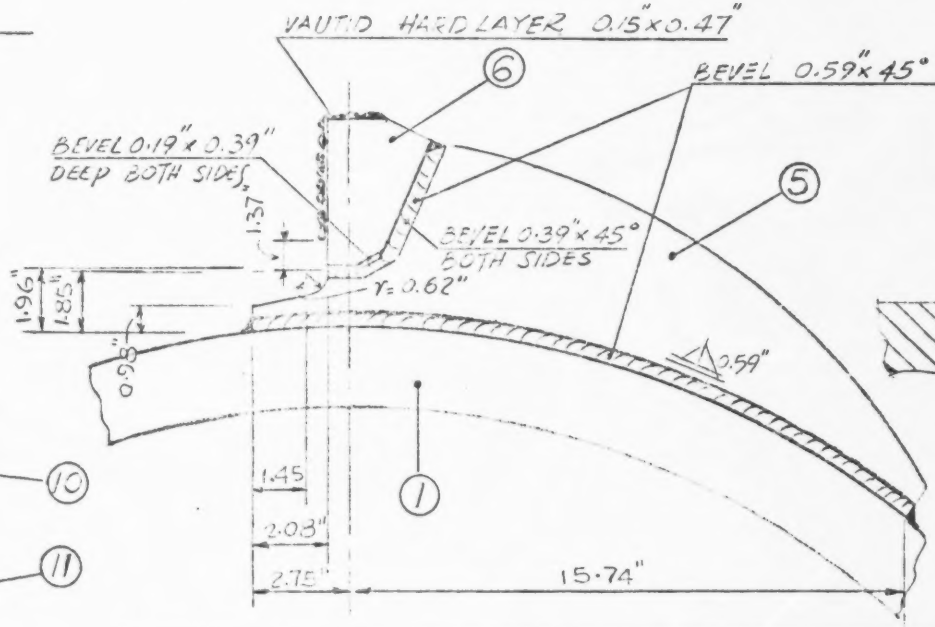
D. This Service Classification shall be applicable to 25 cycle service, taken separately from 60 cycle service, for Customers taking 25 cycle service under Schedule P.S.C. No. 309, as of the effective date hereof. Such service shall continue in accordance with the provisions of General Information as shown on Leaves Nos. 57 through 71.

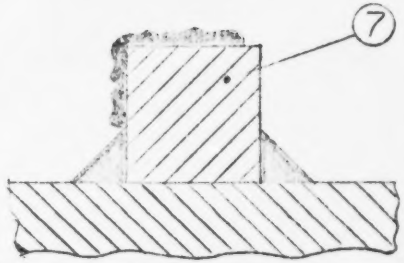
E. Whenever any customer's taking of 25 cycle service hereunder, exceeds the limitations set forth on Leaves Nos. 59 through 71 inclusive of General Information by a tolerance of more than 50 KW or 5% of the stated limitation amount, whichever is the lesser amount, there shall be an additional charge for such excess taking, in addition to the charges set forth in this service classification under RATE, of $2.50 per kilowatt per month.



DETAIL 'A'

SCALE : HALF SIZE





SECTION C-C

SCALE : HALF SIZE

TOTAL ≈ 18,915 lbs.

"HAZEMAG"

BULK REFUSE CRUSHING PLANT

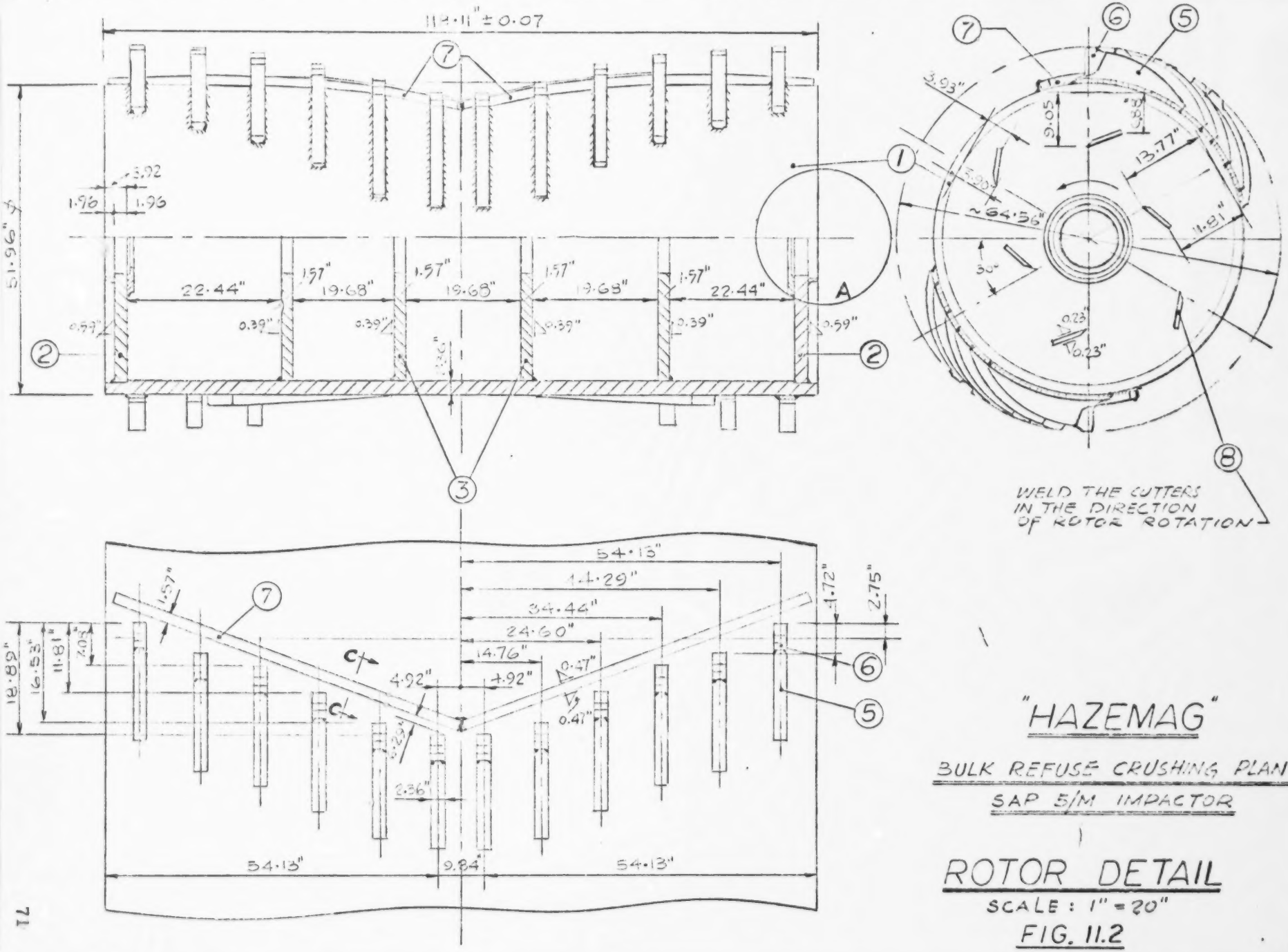
SAP 5/M IMPACTOR

ROTOR DETAIL

FIG. 11.1

NOTE: FINISHED ROTOR & SHAFT DYNAMICALLY BALANCED (MD^2 = 280 000 lb FT^2)

Qu.	DESCRIPTION	PART	MATERIAL (GERMAN STDS.)	REMARKS	WEIGHT (lbs)
1	ROTOR COVER PIPE (52"Φx2.36"..118")	1	MR ST 37-2	n.z.K4-10446	12,345
2	SIDE PLATE	2		n.z.K4-22523	2,028
4	PROTECTIVE PLATE (1.57"x47.24")	3	RSt. 37-2	n.z.K4-10481	3,042
24	RIB (2.36 x 6.92 x 19.92)	5	St. 52-3	n.z.K3-22524	1,058
24	IMPACT TOOTH (2.36"x3.14"x4.72")	6	HARD MANGANESE	n.z.K4-23560	180
4	PROTECTIVE STRIP (1.57"...62.20")	7	St-52-3	O.Z.	176
12	SIDE CUTTERS (1.13"x0.78"...5.90")	8	St-37-2	n.z.K4-19846	16
2	WEDGE CONICAL NUT (1.44" x 12", RFN 7012)	9			55
2	PROTECTIVE PLATE	10		n.z.K4-22525	
8	BOLT (M 0.39" x 0.78" >IN 601)	11			



"HAZEMAG"

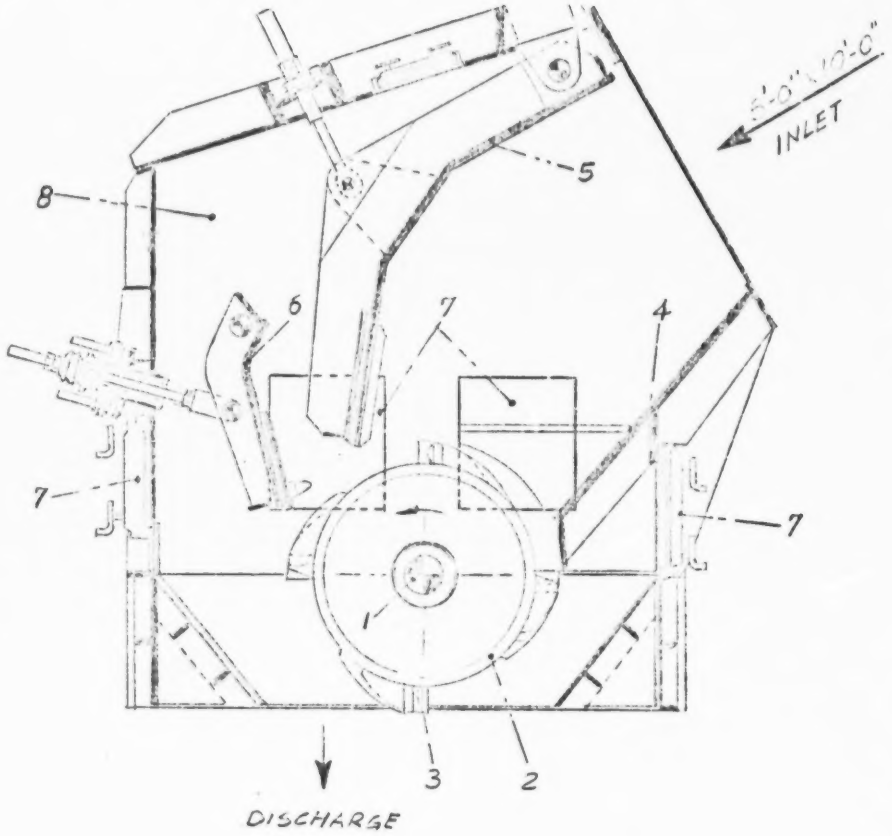
BULK REFUSE CRUSHING PLANT

SAP 5/M IMPACTOR

ROTOR DETAIL

SCALE : 1" = 20"

FIG. 11.2



LEGEND

1 ROTOR SHAFT
2 ROTOR
3 BLOW BAR
4 INLET CHUTE
5 FRONT IMPACT MECHANISM
6 REAR IMPACT MECHANISM
7 INSPECTION & MOUNTING FLAPS
8 CRUSHER HOUSING

MACHINE WEIGHT : 104,500 lbs.
ROTOR WEIGHT : 26,000 lbs.
FEED OPENING : 5'-0" x 10'-0"
CAPACITY : UP TO 500 CU.YD./HR.

"HAZEMAG"

BULK REFUSE CRUSHING PLANT

SAP 5/M IMPACTOR

CRUSHER ASSEMBLY

FIG. 11.3

12. POWER CALCULATIONS

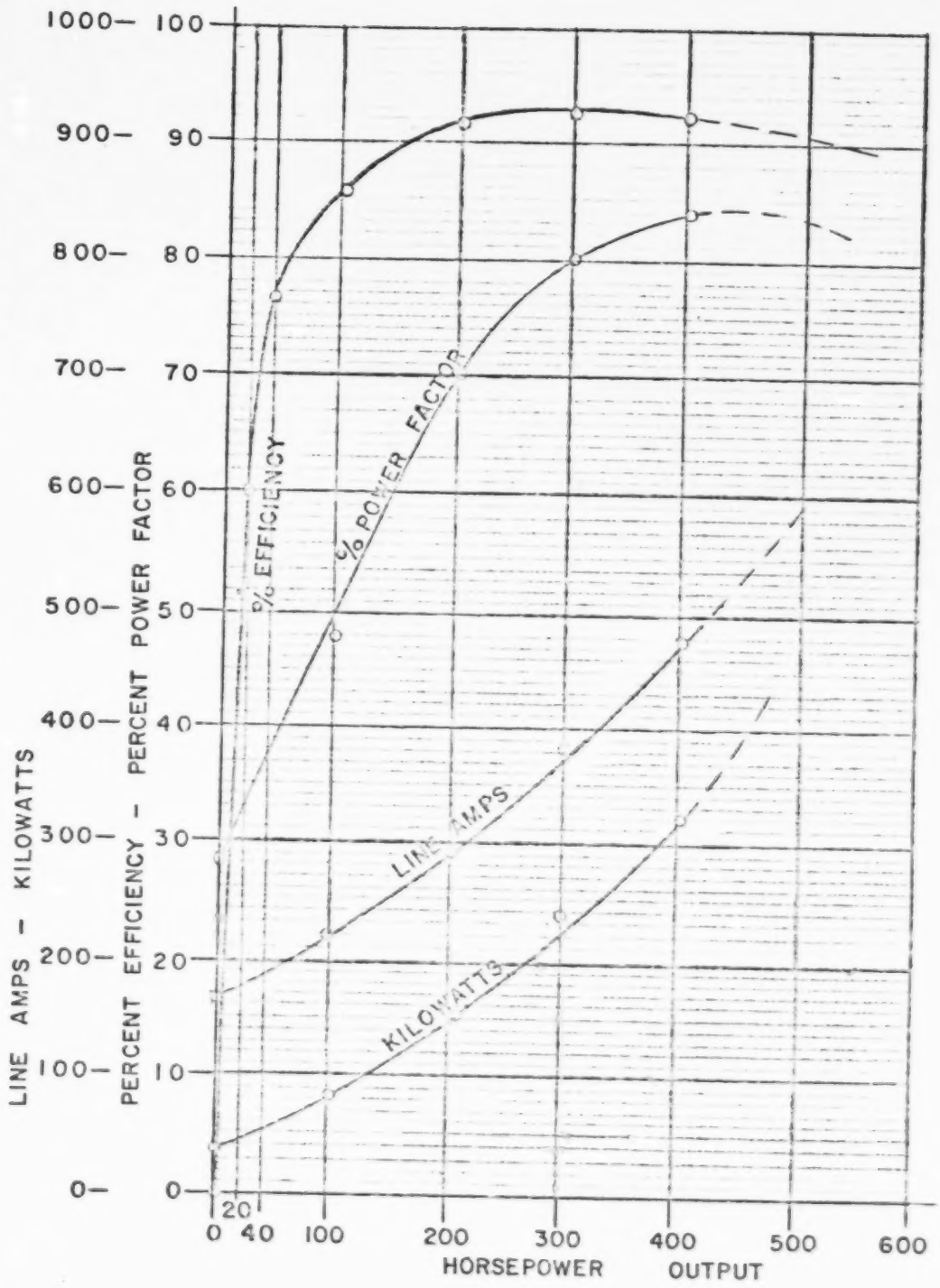


FIG. 12.1 CHARACTERISTIC CURVES OF 400 HP CRUSHER MOTOR

Power Calculations - Sheet 1 of 5

Power Requirements for Bulk Refuse Crusher and Ancillaries

	Conn. HP	Conn. KW	Avg. KW Demand	Peak KW Demand	Peak RKVA Demand
Crushing Mixed Bulk					
Crusher	400	298	110	236	209 (Sh. 2)
Ancillaries	193	144	86	115	80 (Sh. 3)
Total	593	442	196	351	289
Crushing Incombustibles					
Crusher	400	298	178	382	248 (Sh. 2)
Ancillaries (b)	193	144	86	115	80 (Sh. 3)
Total	593	442	264	497	328

Note: Average KW and peak KW demands for Crusher determined from KWH meter readings adjusted for data obtained by computer aided analyses of 57-hour readout of Amp recorder chart while crushing mixed bulk (shown in part on Chart 8.2.1) and Characteristic Curves of 400 HP Crusher Motor, Fig. 12.1.

Analyses determined the following:

a) integrated average KW demand for crushing mixed bulk and also for crushing incombustibles.

b) 15-minute integrated peak KW demand for crushing mixed bulk and also for crushing incombustibles.

c) total energy consumed in crushing mixed bulk and also for crushing incombustibles.

d) energy consumed in recorded operating intervals, when free-wheeling or when crushing; i.e. 1334 KWH (21% of energy) consumed when free-wheeling for 22 hours (39% of total recorded operating time on Amp recorder) or conversely 4940 KWH (79% of energy) consumed when crushing for 35 hours (61% of total recorded operating time on Amp recorder).

Power Calculations - Sheet 2 of 5

Computation of Peak RKVA for
Bulk Refuse Crusher

Mixed Bulk

Peak KW = 236 (Sh. 1)

From Fig. 12.1, Power Factor = cos θ = .750
θ = 41.5°, tan θ = .885

Peak RKVA = tan θ x Peak KW
= .885 x 236 = 209

Incombustibles

Peak KW = 382 (Sh. 2)

From Fig. 12.1, Power Factor = cos θ = .840
θ = 33°, tan θ = .650

Peak RKVA = tan θ x Peak KW
= .650 x 382 = 248

Power Calculations - Sheet 3 of 5

Power Requirements for Bulk Refuse Crusher
Ancillaries

Ancillary	Conn. HP	Conn. KW
Vibratory Feed Conveyor	25	18.7
Vibratory Discharge Conveyor	25	18.7
Exhaust Fan	25	18.7
Air Lock	5	3.7
Discharge Apron Conveyor	15	11.2
Crane Holding	40	29.8
Crane Closing	40	29.8
Crane Trolley	3	2.2
Crane Bridge	15	11.2
Total	193	144.0

Average KW = .60 x 144 = 86.4 KW
Peak KW = .80 x 144 = 115.2 KW
Power Factor = cos θ = .820, θ = 35°, tan θ = .696
Peak RKVA = tan θ x Peak KW
= .696 x 115.2 = 80

Power Calculations - Sheet 4 of 5

Computation of Incremental Cost
of Electricity for Crushing Mixed Bulk
(Niagara Mohawk Power Corp. Service Classification No. 3)
Operations based on 8 hours/day and
5 days/week or 173.3 hours/month

Energy Charge		
Crusher	110 KW (Sh. 1)	
Ancillaries	86 KW (Sh. 1)	
	196 KW x 173.3 hr/mo	
	= 34,000 KWH	
	@ 0.46¢/KWH	= $156.50
Demand Charge		
Crusher	236 KW (Sh. 1)	
Ancillaries	115 KW (Sh. 1)	
	351 KW	
	@ ($1.69-$0.20)/KW	= $523.00
Reactive Demand Charge		
Crusher	209 RKVA (Sh. 1)	
Ancillaries	80 RKVA (Sh. 1)	
	289 RKVA	
less 1/3 KW Demand =	-117	
	172 RKVA	
	@ $0.28/RKVA	= $ 48.20
Total Monthly Bill		= $727.70

Electricity Cost Per Ton of Mixed Bulk
(Based on 11 Tons/Hr Through-put)

$$\frac{\$727.70}{173.3 \times 11} = \$0.382/\text{ton}$$

Electricity Cost Per KWH for Crushing Mixed Bulk

$$\frac{\$727.70}{34{,}000\ \text{KWH}} = 2.14¢/\text{KWH}$$

Power Calculations - Sheet 5 of 5

Computation of Incremental Cost
of Electricity for Crushing Incombustibles
(Niagara Mohawk Power Corp. Service Classification No. 3)
Operations based on 8 hours/day and
5 days/week or 173.3 hours/month

Energy Charge

Crusher	178 KW (Sh. 1)	
Ancillaries	86 KW (Sh. 1)	
	264 KW x 173.3 hr/mo	
	= 45,750 KWH	
	@ 0.46¢/KWH	= $210.00

Demand Charge

Crusher	382 KW (Sh. 1)	
Ancillaries	115 KW (Sh. 1)	
	497 KW	
	@ ($1.69-$0.20)/KW	= $740.00

Reactive Demand Charge

Crusher	248 RKVA (Sh. 1)	
Ancillaries	80 RKVA (Sh. 1)	
	328 RKVA	
less 1/3 KW Demand =	-166	
	162 RKVA	
	@ $0.28/RKVA	= $ 45.50

Total Monthly Bill = $995.50

Electricity Cost Per Ton of Incombustibles
(Based on 6 Tons/Hr Through-put)

$$\frac{\$995.50}{173.3 \times 6} = \$0.955/\text{ton}$$

Electricity Cost Per KWH for Crushing Incombustibles

$$\frac{\$995.50}{45{,}750 \text{ KWH}} = 2.18¢/\text{KWH}$$

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